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Klebenow,
D.

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CONTROLLED FIRE AS A MANAGEMENT TOOL IN THE PINYON-JUNIPER WOODLAND, NEVADA

Cooperative Research Between
USDA Forest Service
and
Nevada Agricultural Experiment Station

By: D. Klebenow
R. Beall
A. Bruner
R. Mason
B. Roundy
W. Stager
K. Ward

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INTRODUCTION

A cooperative research grant between the USDA, Forest Service and the Nevada Agricultural Experiment Station has been completed after a three year period (1975-77). Objectives were determining certain ecological effects of fire on pinyon-juniper woodlands and how prescribed burning could best serve as a management tool.

This completion report is divided into five sections. Each section contains its own introduction, discussion and results. The five sections are as follows: 1) determining factors necessary for successful pinyon-juniper burning, 2) vegetation response, 3) mule deer response, 4) small mammal and bird population response, and 5) infiltration rate and sediment production as influenced by prescribed burning. An appendix has been added to provide a summary of all pre-burn data such as vegetation measurements, species lists, infiltration rates, and plot location maps.

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PRESCRIBED BURNING OF PINYON-JUNIPER WOODLANDS IN NEVADA

INTRODUCTION

Pinyon and juniper (Pinus monophyla) (Juniperus osteosperma) occupy approximately 14% of Nevada (Blackburn and Tueller, 1970). Invasion of pinyon-juniper often results in the elimination of understory vegetation due to competition. This results in decreased forage for livestock and wildlife. Prescribed burning is an inexpensive method of converting small portions of this vegetation to brush-grassland communities that would benefit both wildlife and livestock grazing (Aro, 1971).

Most of the woodlands in Nevada have a large degree of non-uniformity. This is due to the abruptly changing topography, soil depth, aspect and elevation to mention a few. This non-uniformity provides many natural fire breaks in most stands and makes it easy to delineate areas for prescribed burning.

During 1975 and 1976, 30 attempts were made to burn pinyon-juniper vegetation in the spring and fall. Twelve of these attempts were successful producing burns varying in size from 2 to 60 acres.

METHODS

Burning attempts were made from the fall of 1974 through fall 1976, out of fire season, at three locations within the State. The three locations were White River in the White Pine District, Cherry Springs in the Lamoille District on the Humboldt National Forest, and Blackwell Canyon in the Bridgeport District of the Toiyabe National Forest. The majority of attempts and all the successful burns were in the White River area (Figure 1).

Prior to burning, the following vegetation data was gathered on 0.1 hectare plots: percent ground cover of litter, bare ground, rock, pavement and vegetation, pinyon and juniper counts by age class, and estimated green shrub weight. This data and maps showing plot locations are summarized in Appendix A, B, C and D.

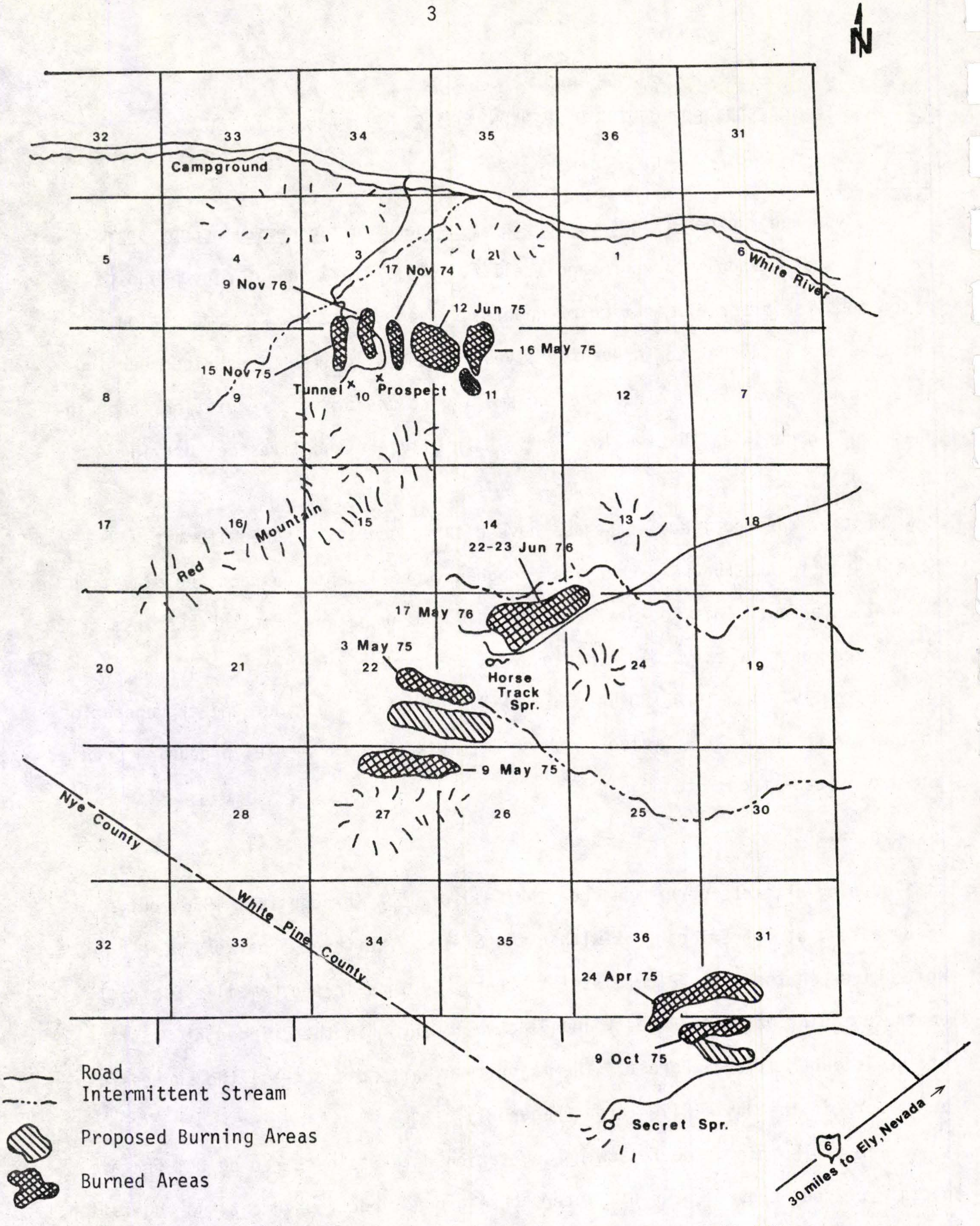

N
32
33
34
35
36
31
Campground
5
4
3
2
1
6
White River
17 Nov 74
9 Nov 76
12 Jun 75
16 May 75
15 Nov 75
Tunnel
Prospect
8
9
10
11
12
7
17
16
Red
Mountain
15
14
13
18
22-23 Jun 76
17 May 76
3 May 75
20
21
22
Horse
Track
Spr.
24
19
9 May 75
28
27
26
25
30
Nye County
White Pine County
32
33
34
35
36
31
24 Apr 75
9 Oct 75
Secret Spr.
6
30 miles to Ely, Nevada
Road
Intermittent Stream
Proposed Burning Areas
Burned Areas

Figure 1. Areas and dates of experimental burning attempts - fall 1974 to fall 1976 White River area, Humboldt National Forest, Nevada.

Pinyon-Juniper Communities

It is important to categorize the various pinyon-juniper communities when discussing their burning. Blackburn and Tueller (1970) describe five general communities of pinyon-juniper and give a species cover percenta e for each named community. By adding a range of percent tree cover to those named communities, the following divisions are made: 0-2% open, 2-9% dispersed, 9-23% scattered, 23-25% dense and 35+% closed.

Two of these five communities are suitable for prescribed burning. The open and dispersed communities (Figure 2) are excluded because of the small degree of influence they have on the community at that stage. Blackburn and Tueller (1970) state that the scattered community appears to be the point in the invasion pattern where pinyon and juniper are starting to exert their influence and begin to dominate the understory species causing a sharp reduction in their vigor and frequency. The closed stands (Figure 3) are excluded because of the difficulty in burning them out of fire season. Ten attempts to burn closed stands were unsuccessful. Hazardous conditions are necessary to burn these stands. One attempt (Table 1) was made June 24, 1975 with a temperature of 67°F (19°C), relative humidity at 5% and winds at 10-35 mph (16-56 kilometers per hour). These conditions failed to carry the fire. When understory shrubs are absent, as in closed stands, it becomes necessary to pick conditions that will create a crown fire. Because of the hazards, closed stands might best be burned by wildfires during the fire season, and this is out of the realm of prescribed burning.

Two communities remain which burning might best be concentrated - scattered and dense (Figure 4). The following discussion is based on burns in these two pinyon-juniper communities.

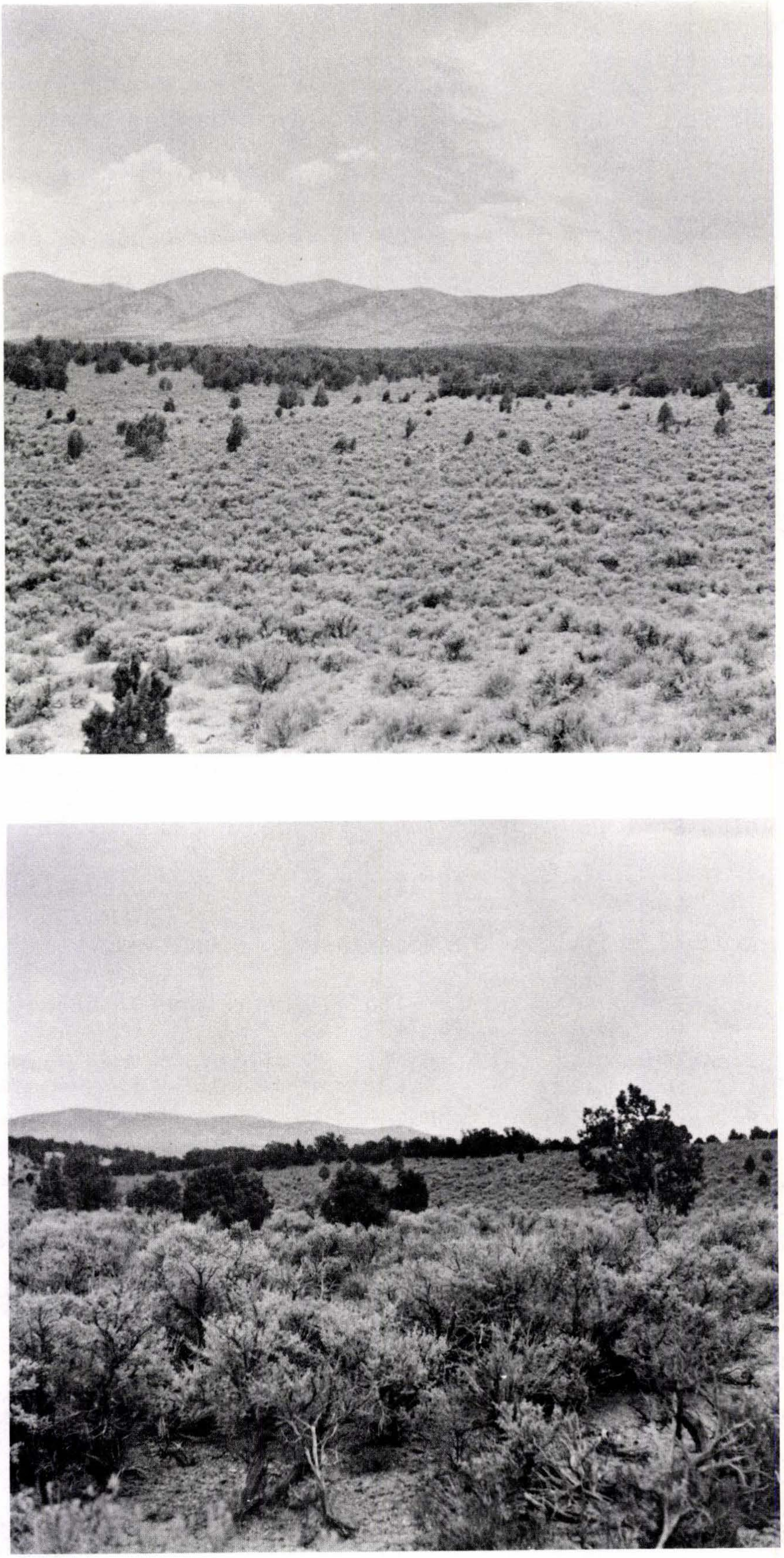


Figure 2. Open pinyon-juniper community (top). Dispersed pinyon-juniper community (bottom). These vegetation types are difficult to burn out of fire season.

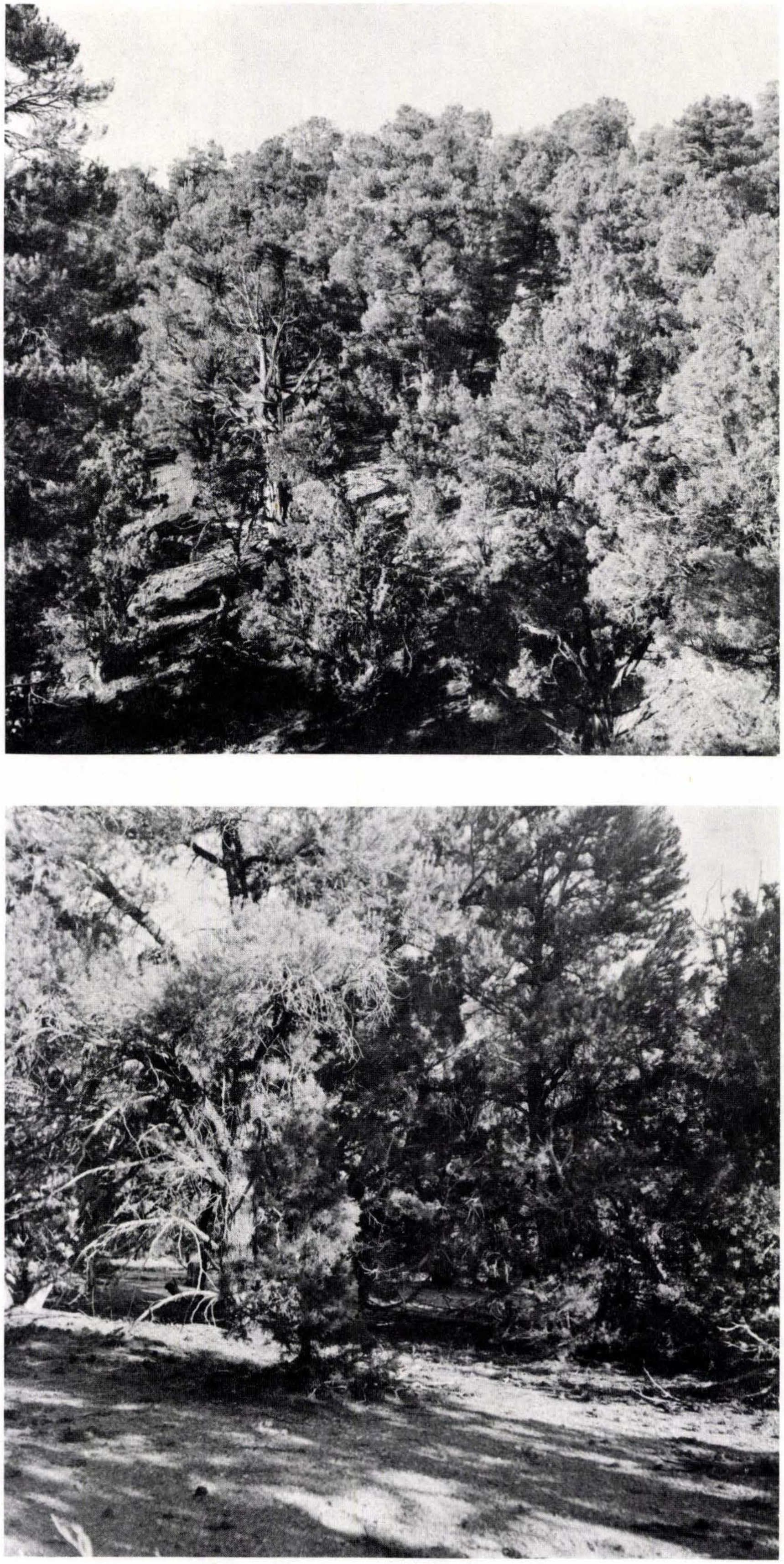


Figure 3. Closed pinyon-juniper community - extremely difficult to burn out of fire season.

Table 1. Summary of burning attempts and conditions in the White River and Cherry Springs study areas during 1975-76 on the Humboldt National Forest, Nevada.

		Burning Conditions							
Burn Date	Location	Time[1]	Temp.[2]	Rel. Humidity[3]	Wind Speed[4]	Soil Moisture[5]	Plant Moisture[6]	Burn Success[7]	Acres
17 Nov 74	WR-Upper	1315	11	26	0-16	-	-	2	2
18 Nov 74	" [8] "	1230	12	27	13-19	-	-	3	
24 Apr 75	WR-Lower	1400	16	26	8-40	13	50	1	18
2 May 75	" Middle	1445	14	20	0-13	12	48	2	
3 May 75	" "	1100	13	26	0-16	12	48	2	9
9 May 75	" "	1510	18	16	3-13	12	50	1	19
16 May 75	WR-Upper	1030	18	14	0- 8	12	49	2	3
28 May 75	Cherry Sprgs	1430	12	32	5-16	13	54	3	
29 May 75	" "	1300	18	20	0-16	13	54	3	
12 Jun 75	WR-Upper	1400	25	8	0-19	9	47	1	9
17 Jun 75	Cherry Sprgs	1200	12	90	0- 8	10	49	3	
24 Jun 75	" "	1215	19	5	16-56	8	49	3	
24 Jun 75	" "	1430	13	35	0- 8	8	49	3	
26 Jun 75	" "	1145	18	26	0-13	8	48	3	
26 Jun 75	" "	1500	23	16	0-10	8	48	3	
9 Oct 75	WR-Lower	1300	12	18	0-16	9	38	2	8
26 Oct 75	Cherry Sprgs	1100	11	40	8-32	17	35	3	
15 Nov 75	WR-Upper	1400	13	12	0-11	3	-	2	3
3 May 76	Blackwell Canyon	1300	26	7	0-13	-	42	0[9]	
10 May 76	WR - Middle	1720	21	17	0-13	11	53	3	
11 May 76	WR-Lower	1630	21	23	0-16	11	53	-	
17 May 76	WR-Middle	1330	22	19	0-19	-	-	1	60
27 May 76	" "	1515	26	17	5-24	6	-	3	
28 May 76	Cherry Sprgs	1400	22	19	3-19	5	-	3	
28 May 76	" "	1730	18	9	8-32	5	-	3	
22 Jun 76	WR-Middle	1600	19	20	10-29	2	46	1	25
23 Jun 76	" "	1500	22	12	6-24	2	46	1	45
9 Nov 76	WR-Upper	1300	13	28	0-13	7	49	1	6
10 Nov 76	WR-Lower	1430	10	40	0	7	49	3	
9 Dec 76	" "	1130	2	52	3-16	11	49	3	

---

[1] Time at ignition

[2] Degrees C

[3] Percent

[4] Kilometers/hr.

[5] Sample 0-10 cm deep

[6] Percent of green wt. pinyon

[7] 1 = fire carried
2 = fire needed lighting assistance
3 = would not burn

[8] White River

[9] Too hazardous to light

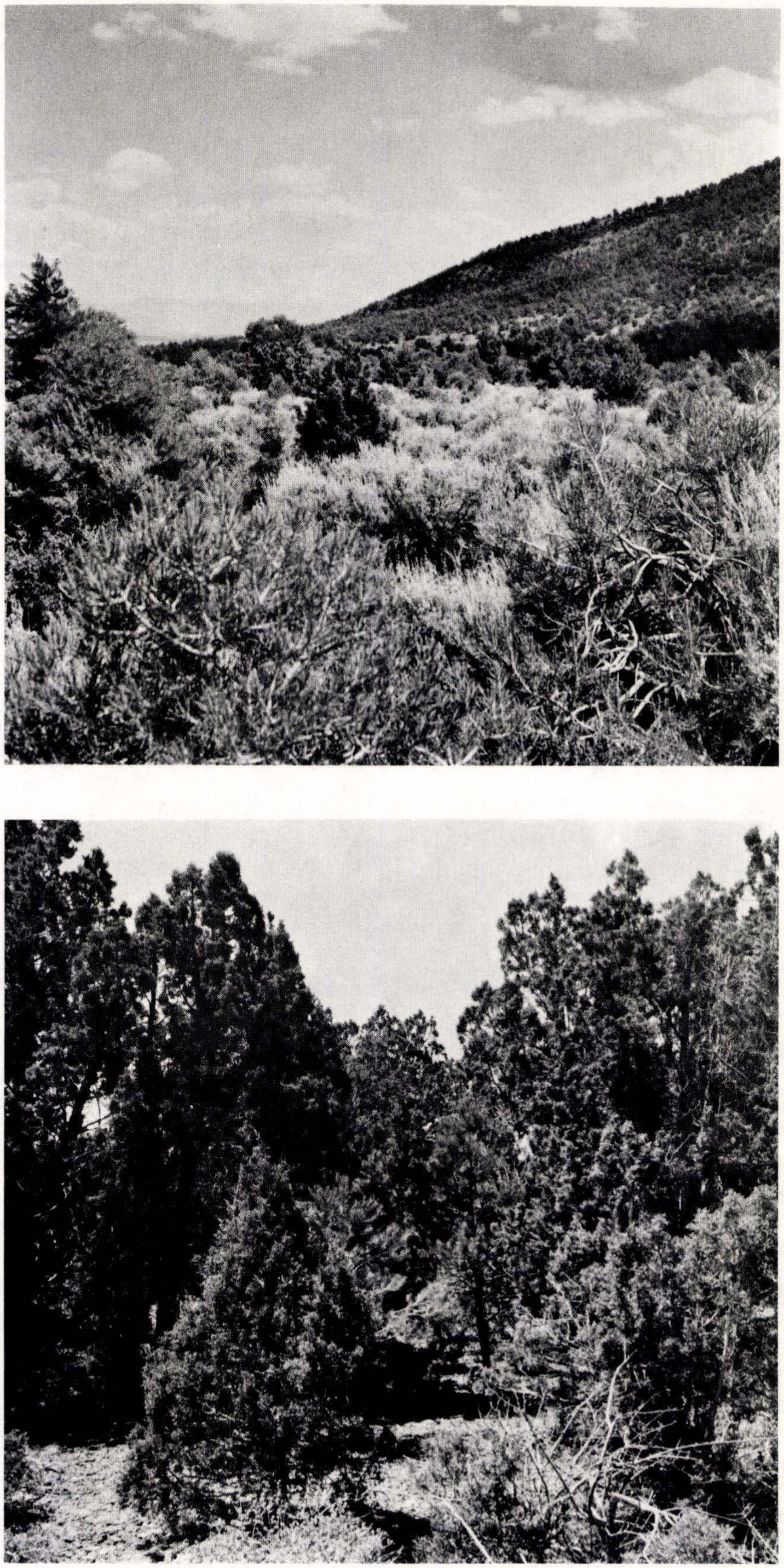


Figure 4. Scattered pinyon-juniper community (top) and dense pinyon-juniper community (bottom). All successful burns occurred in these vegetation types.

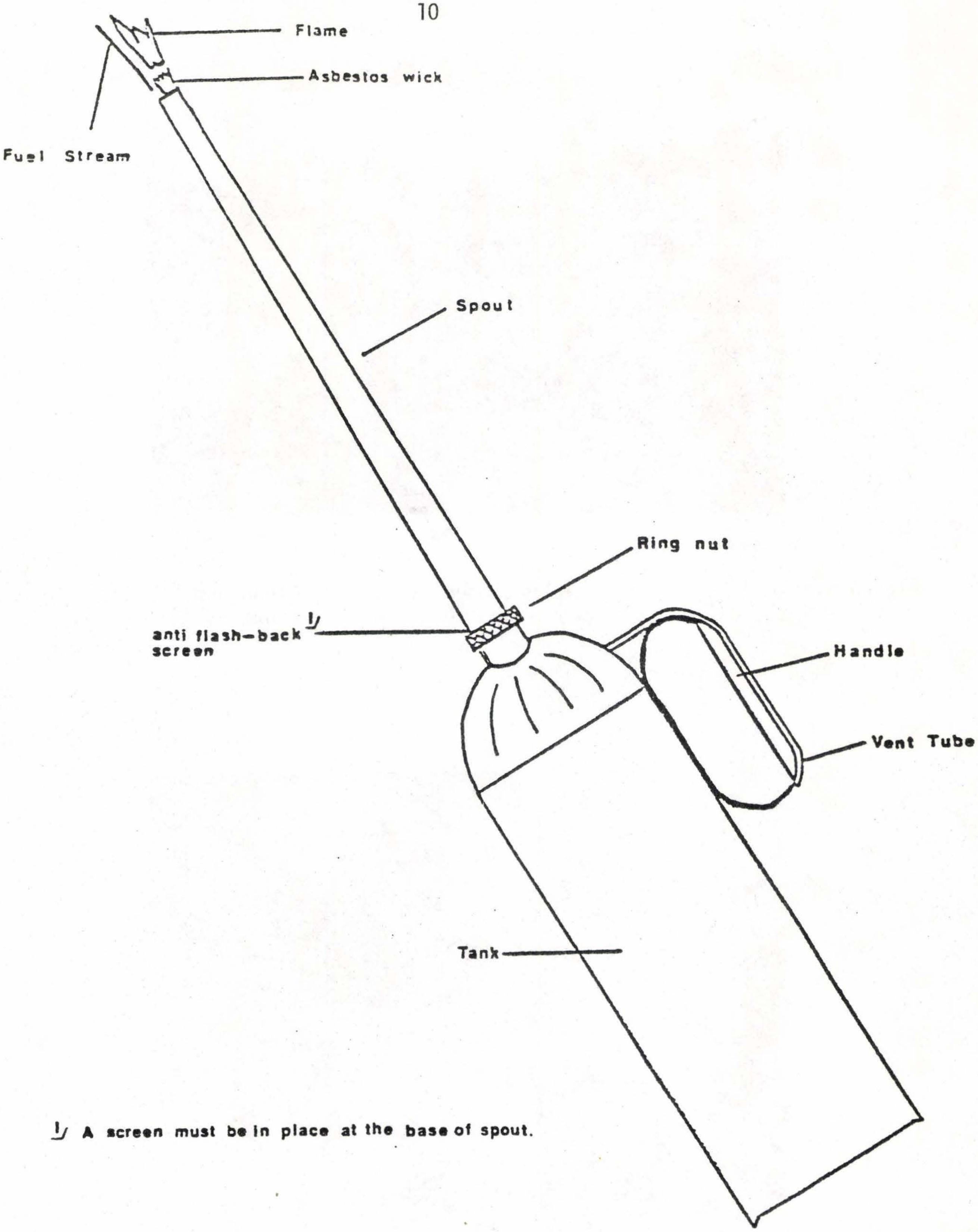
Ignition

An ideal tool for igniting trees is the orchard heater lighter (Smudge Pot Lighter) (Figure 5). Conventional drip torches and flame throwers were used for comparison. The long spout of the smudge pot lighter gives a good pouring balance and provides some distance from the flame. It will emit a heavy stream of fuel, which when mixed 50-50 (50% gasoline and 50% diesel oil) will remain burning on the bark or needles for 10 to 20 seconds. To ignite a tree, pour a heavy stream of burning fuel up and down the trunk from the ground up to 5 or 6 feet. The dead ground needles and any shrubs under the tree should be ignited while backing out from under the canopy on the windward side. By directly lighting several trees, the ambient temperature of the area increases rapidly and understory plants are ignited. It is this initial torch of several trees producing a flame length of 20 to 30 feet that is necessary to develop a fire which will carry (Figure 7). Heat and flame are not generated fast enough if only the shrubs are lit, especially those in the tree interspaces. Two precautions of the tool are: the gasoline must be well mixed with the diesel oil and the anti-flashback screem must be present in the spout.

Several techniques have been tried in igniting pinyon-juniper stands. The best method is two men walking perpendicular to the wind along the windward edge of the area to be burned (headfiring). The lead man can either leave unlit holes for the following man to light or they can leap frog past one another. Either way, this has been the easiest and most efficient way to start pinyon-juniper fires.

Fire Evaluation

Each burning attempt was done under a different set of atmospheric conditions as well as varying fuel loads. Table 1 summarizes the burns showing atmospheric conditions, soil moisture, plant moisture and a rating of burn success.


Flame
Asbestos wick
Fuel Stream
Spout
Ring nut
anti flash-back[1] screen
Handle
Vent Tube
Tank

[1] A screen must be in place at the base of spout.

Figure 5. The smudge pot lighter is a good tool for igniting pinyon-juniper trees.

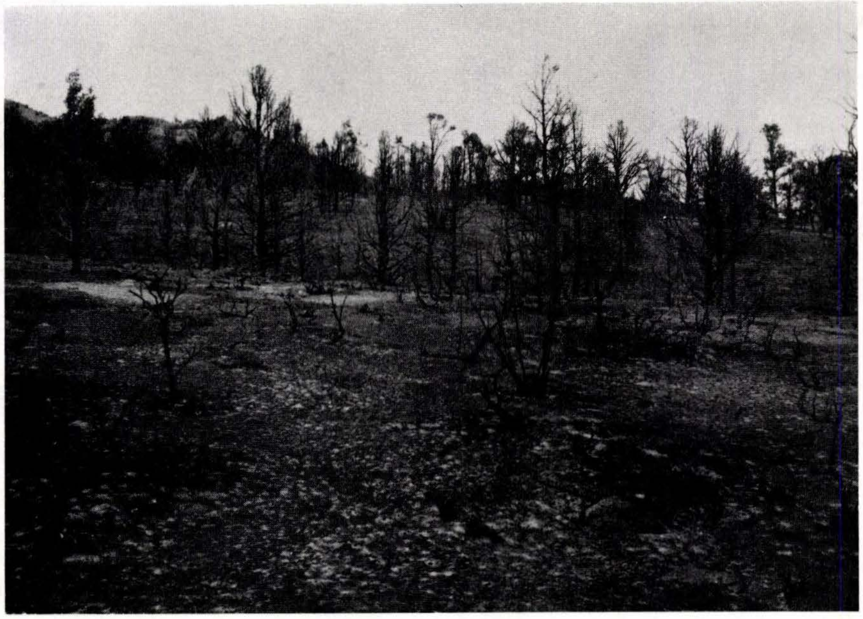


Figure 6. A dense pinyon-juniper community after a clean burn. Conditions the day of this burn added to the simple score of 126.

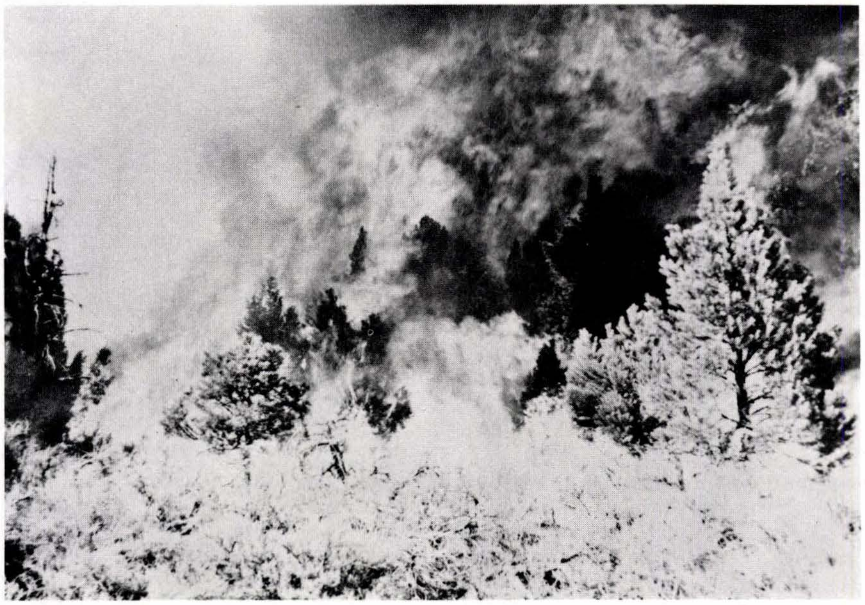


Figure 7. A class 1 or self-sustaining fire capable of carrying through the vegetation. May 9, 1975 burn at White River, Nevada.

Fire temperatures were monitored at the soil surface and at 1 and 2 centimeters below the soil surface in the coppice and interspaces between plants. This data was not used for evaluation; however, it is summarized in Appendix E for burn history reference.

Objective rating of burns is difficult in these highly volatile pinyon-juniper vegetation types, the consumption of fuel by the fire seems to be the same whether the fire carries well or only the immediate ignition area burns. For this reason, rating falls into three simple categories: 1) after the ignition area is lit, the fire carries by itself burning the area clean, with only some re-torching necessary; 2) the ignition area needs to be continually lit during the entire burn period and some unburned islands occur; 3) the fire will not carry beyond the ignition area.

RESULTS

There are many variable conditions at the time of each burn (Table 1). Many of the atmospheric conditions are compensating. A low value of one can be offset by a high value in another. When maximum wind speed is added to air temperature and percent vegetation cover, this composite score becomes a good indicator of burning success in the scattered and dense pinyon-juniper communities (Table 2). The score is derived by simply adding maximum wind speed (mph) to air temperature in degrees Fahrenheit and vegetation cover in percent (maximum mph + F^O + veg. cover = score). If metric measurements are used, the formula is 0.6 (kph) + 1.8 (C^O) + % veg. cover + 32 = score.

Considering the three subjective fire class ratings of 1, 2 and 3 (Table 2), a score of less than 110 will not provide conditions necessary for burning. A score of 110 to 125 indicates conditions prevail for a class 2 fire. A score of 125 to 130 indicates conditions are optimum for a class 1 or self-sustaining fire that will carry (Figure 6). A score higher than 130 indicates a hazardous condition in the scattered and dense pinyon-juniper communities.

Table 2. Composit score of three variables and burn ratings during 1974-76 burns at White River, Nevada. Score is derived by using the following formula: Maximum mph + F^o + Veg. cover = score.

Burn Date	Wind Speed (mph)	Temp (^{o}F)	Veg. Cover %	Score	Simple Score Rating	Discriminant Analysis Rating	Actual Rating
9 Dec 76	10	35	49	94	3[1]	3	3
10 Nov 76	0	50	51	101	3	3	3
				110-			
15 Nov 75	7	55	56	118	2	2	2
9 Oct 75	10	53	56	119	2	2	2
16 May 75	5	65	50	120	2	2	2
10 May 76	8	70	43	121	2	3	3
2 May 75	8	58	56	122	2	2	2
3 May 75	10	56	56	122	2	2	2
				125-			
9 Nov 76	8	55	63	126	1	2	1
17 May 76	12	72	43	127	1	1	1
27 May 76	6	78	43	127	1	2	3
22 Jun 76	18	66	43	127	1	1	1
17 Nov 74	10	51	66	127	1	1	1
9 May 75	8	65	55	12	1	2	1
23 Jun 76	15	71	43	129	1	1	1
12 Jun 75	12	77	41	130	1	1	1
				130-			
24 Apr 75	25	60	46	131	1	1	1
3 May 76	8	78	48	134	0	-	0

---

[1] 3 = No burn
2 = Continual re-torching necessary
1 = Clean burn, fire carries
0 = Too hazardous to burn

These simple scores were compaired on 17 burns (Table 2). Fifteen of the 17 or 88% were correctly classified. A discriminant analysis was used to construct a weighted score of the variables, wind, temperature and cover, to separate the burns into three classes. This more sophisticated method correctly classified 82% of the burns. With more observations, these results would change, however, the simple score method compares very favorably with the discriminant analysis.

This simple scoring applies to the cooler months of April, May, October and November or when air temperatures are below 75°F and wind speeds are above 5 mph. Total vegetation cover varied from 42 to 66 percent on all successful burns (Table 3). Forb and grass cover was minimal in all areas.

Table 3. Pre-burn tree and shrub cover of successful burns in the White River Area, Humboldt National Forest, Nevada.

Burn Date	Community Description	Location	Percent Cover			Estimated Shrub Green Weight	
			Shrubs	Trees	Total	lb/a.	Kg/ha.
17 Nov 74	Dense	Upper White River	42	24	66	-	-
16 May 75	Scattered	" " "	36	14	50	9932	11120
12 Jun 75	Scattered	" " "	27	14	42	7253	8105
15 Nov 75	Scattered	" " "	41	15	56	-	-
9 Nov 76	Scattered	" " "	44	19	63	7841	8790
3 May 75	Dispersed	Middle White River	48	8	56	12502	14020
9 May 75	Dense	" " "	27	28	55	11194	12520
22 Jun 76	Dispersed	" " "	36	7	43	4007	4460
23 Jun 76	Dispersed	" " "	39	4	43	4356	4850
17 May 76	Dispersed	" " "	36	7	43	4007	4460
24 Apr 75	Dispersed	Lower White River	46	8	54	22759	24865
9 Oct 75	Dispersed	" " "	52	4	56	-	-

There appears to be a narrow separation between conditions necessary for prescribed burning which will adequately carry a fire and those of a wild fire which develop concern toward suppression. The score of 130 appears to be close to this separation point.

Of those burning attempts made during the life of the project, conditions above 130 in the scattered and dense pinyon-juniper communities were not tested and no fires became dangerous or burned excessive acreages beyond the expected limits.

It is certain there are numerous and more complex variables involved in fire spread potential; however, this simple score seems to work as a general rule of thumb and it provides a guide for the land manager.

CONCLUSION

Land managers who would like to do some out-of-fire season burning are sometimes reluctant because they are not sure of the conditions needed to carry a fire. Many times, a day is spent in preparation and travel to the proposed burn site only to find that conditions were not adequate to carry a fire. A simple rule of thumb would aid in this burn or no-burn decision.

If the percent cover of vegetation was measured prior to burning and the desired wind direction known for ignition points, the manager could better predict his chances for a successful burn from the daily weather forecasts.

With vegetation cover known, the manager can wait for the desired combination of wind speed and temperature to provide an acceptable score for burning.

INFLUENCE OF PRESCRIBED BURNING ON INFILTRATION AND SEDIMENT PRODUCTION IN THE PINYON-JUNIPER WOODLAND

INTRODUCTION

An evaluation of the environmental consequences of prescribed burning in the Great Basin should include information on soil infiltration rate and sediment production. Infiltration rate is directly related to peak floods and sediment production from intense summer thundershowers characteristic of the Great Basin (Blackburn, 1975). On arid and semi-arid rangelands, areas between plants known as dune interspaces produce much more runoff and sediment than do areas of soil and litter accumulation under plants referred to as coppice dunes (Blackburn, 1975). However, burning can destroy vegetation and litter cover on coppice dunes and change physical properties of the soil that affect infiltration and sediment production. The intent of this study was to measure infiltration rates and sediment production in relation to soil cover and physical factors in unburned and burned pinyon-juniper communities. The specific objectives were:

1. To determine the effect of prescribed burning on infiltration rates and sediment production.
2. To determine factors influencing infiltration rate and sediment production.

REVIEW OF LITERATURE

Pinyon-Juniper Studies

Blackburn (1975) studied infiltration rates and sediment production on five watersheds in Nevada, including eight pinyon and/or juniper communities with a variety of understory species. Coppice dune soil had higher infiltration rates and lower sediment production than did dune interspace soil. He concluded that infiltration and sediment production were controlled by the extent and morphology of the dune interspace surface soil. Infiltration was negatively correlated and sediment positively correlated with a vesicular surface horizon in the interspaces characterized by shallow depth, low organic matter, high pH, high bulk density, high percent silt, massive or platy structure, and poor aggregation, when compared to the granular coppice soil. Plant and litter cover, texture, and soil moisture also influenced infiltration and sediment production. Data from two sites indicated no effect on infiltration or sediment production by either double or single chaining as vegetation conversion treatments.

Gifford (1975) summarized results of studies on the impact of chaining pinyon-juniper on infiltration and sediment production. Probably due to coarse-textured soils, infiltration and erosion rates on chained sites were affected only in a few instances when compared to undisturbed woodland. Any decreased infiltration rates were generally the result of severe mechanical disturbance of surface soils associated with the chained-with-windrowing treatment. The debris-in-place treatments controlled sediment production. On the debris-windrowed treatments sediment was increased 1.6 to 6 times above the undistrubed woodland level when a slight increase in runoff occurred. Total porosity of surface soil, bare soil surface, soil surface texture, and vegetative crown cover were important variables influencing infiltration rates.

Burning Effects

The effect of burning on infiltration and erosion depends on vegetation conditions, intensity of the fire, topography, soil type and soil conditions. The majority of studies have shown fire to decrease infiltration and favor erosion. Some of the fire-caused conditions that have been reported to decrease infiltration rates and increase erosion include destruction of soil-protecting vegetation and litter, decrease in soil porosity and permeability, and possible intensification of water repellency in soils.

Dwyer and Pieper (1967) found that fire reduced litter cover for 3 years in the pinyon-juniper woodland in New Mexico. In central Arizona, burning decreased infiltration on steep mountain slopes by destroying plant cover, litter, and organic matter in the top layer of soil, causing active erosion (Hendricks and Johnson, 1944). Arend (1941), however, found that a decreased infiltration rate after burning was caused only in part by the destruction of litter. He concluded that burning caused physical changes in the mineral soil that reduced water absorbancy. DeByle and Packer (1972) found that reduction in bulk density and porosity after burning decreased infiltration and adversely affected soil stability.

Blackburn (1975) found water-repellent areas under some juniper trees caused lower infiltration rates. Fire can intensify water repellency in some cases (Adams, 1970) and destroy repellency on the surface, but intensify repellency below the soil surface in other cases (Hassain, et al., 1969). Burning of pinyon-juniper debris in place on sandy loam soils decreased infiltration rates, possibly due to the formation of nonwettable soils. (Buckhouse, 1975).

STUDY SITES AND METHODS

Recent and year-old prescribed burns and adjacent unburned areas on the same soil family were studied at two sites near the White River in eastern Nevada. Physiographic, soil, vegetation, and location information for both sites are in Appendix F. Both sites supported a scattered pinyon

(*Pinus monophylla*)-juniper (*Juniperus osteosperma*) community (Blackburn and Tueller, 1970). Big sagebrush (*Artemisia tridentata*) and desert bitterbrush (*Purshia glandulosa*) were the dominant understory species.

Soils are derived from volcanic parent material. The lower White River site has a coarse-loamy, mixed, mesic soil family of Aridic Argixerolls. Studies at this site were conducted on an unburned area and on April, 1975 burned area, both 1 month and 1 year after burning. The middle White River site has a loamy-skeletal, mixed mesic Aridic Argixeroll soil family. Studies at this site were conducted on an unburned area, on an April, 1974 burn 1 year after burning, and on a May, 1975 burn, both 1 month and 1 year after burning.

Infiltration and Sediment

Simulated rainfall was applied at the rate of 8.38 cm/hr for 1 hour to runoff plots with a mobile infiltrometer, using methods described in detail by Blackburn (1973). Plots were positioned to exclusively contain 100% coppice dune or dune interspace. Six replications were included in each unburned and burned area for dune interspace and for each type of coppice dune, i.e., pinyon, juniper, bitterbrush, and big sagebrush. Runoff was collected and weighed in 5-minute intervals and later converted to centimeters of infiltration per hour. Sediment was collected from a 900-ml runoff sample and sediment trapped in the collection apparatus. Samples were oven dried, weighed, and converted to sediment in kilograms per hectare. Initial tests were made with the soil surface initially dry, after which plots were covered with plastic to maintain a uniform soil moisture condition. The same plots were tested again the following day with the soil at or near field capacity.

Cover

Percent cover of litter, rock, bareground, and vegetation was visually estimated for each plot. Vegetation cover refers only to grass, forbs, and tree and shrub seedlings, as mature trees and shrubs were trimmed to near ground level. Average litter depth was measured and used with percent litter cover to calculate litter volume.

Soil

A soil-profile description was made at each site according to procedures outlined by the U.S. Department of Agriculture (1951, 1960). Family-level identifications were made in accordance with the Soil Conservation Service, U.S. Department of Agriculture (1960,1970).

Physiographic placement, percent slope as obtained from an Abney level, and aspect taken from an eight-point compass were recorded for both study sites.

Percent of plot area with a vesicular horizon was estimated. This number was multiplied by a 1 to 5 rating reflecting vesicular horizon thickness and development (Appendix G), and then divided by 5 to give an index of percent vesicular horizon development and occurrence on each plot.

After each field capacity test, the surface and subsurface areas of each plot were examined and percent water-repellent area noted. Water-repellent areas were easily recognized as they remained dry and shed carefully deposited water droplets.

Bulk density at 5 and 10-cm depths, and initial and field capacity surface soil moisture were determined for coppice dune types and interspace on areas adjacent to plots using a Troxler model 1401 surface moisture density gauge.

Particle size distribution of each horizon, including surface horizons of dune interspace and each coppice dune type, was measured by the hydrometer technique (Bouyoucos, 1962).

Organic matter content of each horizon, including surface dune interspace areas and each coppice dune type, was determined by the Walkely-Black method, as outlined by the Oregon State College Soil Testing Laboratory (1954). In the second year of the study, additional surface soil organic matter determinations were made for six replications of each coppice type and interspace in each unburned and burned area.

Analyses

Analysis of variance and Duncan's multiple range test were used to determine significant differences between unburned and burned plots for terminal infiltration rate at the end of 60 minutes, sediment production, percent litter cover, percent bareground, vesicular horizon development, and litter volume. Organic matter data from unburned and burned areas were analyzed similarly. Sediment, litter cover, bareground, and vesicular horizon development data were transformed to square roots to obtain normality.

Forward stepwise multiple regression and correlation and ridge regression (Hoerl and Kennard, 1970) were used to determine important factors influencing infiltration and sediment production. Standard partial regression coefficients were computed to determine the relative importance of independent variables in regression equations.

RESULTS

Treatment Effects

To help elucidate burning effects, significant differences in infiltration rates and sediment production were determined among treatments for coppice and interspace combined, coppice types combined, tree and shrub coppice separate, and coppice types and interspace separate. All significant differences are at the P = 0.05 level.

Infiltration

Lower White River Site. Except for dune interspace alone, all significant differences in infiltration rates among unburned and burned treatments occurred with the soil at field capacity (Table 4 and Appendix H, Figures 1 and 2). The recent and year-old burns had significantly lower infiltration rates than did the unburned control, both with coppice and interspace combined and with coppice alone compared.

Tree coppice on the recent burn and shrub coppice on the recent and year-old burns had significantly lower infiltration rates than the unburned tree and shrub coppices. Infiltration rates on tree coppice were significantly higher than on shrub coppice for all unburned and burned treatments, both with the soil dry and at field capacity. Generally, no significant differences occurred among individual coppice types in unburned or burned areas for both moisture conditions. However, infiltration rates between the two tree species and between the two shrub species were numerically more similar than among individual tree and shrub species.

Infiltration rates were significantly lower on interspaces than on tree and shrub coppices for all unburned and burned treatments for both moisture conditions. Interspace on the year-old burn had a significantly lower infiltration rate than interspace on the recent burn with the soil dry and also had a significantly lower infiltration rate than the interspace on the unburned area with the soil at field capacity.

In summary, burning caused a trend toward lower infiltration rates on coppice dunes that was significant with the soil at field capacity. Shrub coppices generally had lower infiltration rates than tree coppices and showed a decreasing trend in infiltration rates as the burn became older. Interspace infiltration rates were lower than coppice rates.

Middle White River Site. Again, except for dune interspace, all significant differences in infiltration rates among unburned and burned treatments occurred with the soil at field capacity (Table5 and Appendix H , figures 3 and 4). With coppice and interspace combined, only the recent burn had a significantly lower infiltration rate than the unburned control. However, with coppice alone, all burned treatments had significantly lower infiltration rates than the unburned control.

Tree coppice on the recent burn had a significantly lower infiltration rate than unburned tree coppice.

Shrub coppices had a trend toward lower infiltration rates than tree coppices on all but the recent burn treatment. This trend was significant on the year-old burns with the soil at field capacity. Shrub coppices on all burned treatments had significantly lower infiltration rates than shrub coppice on the unburned treatment. Generally, no significant differences occurred among individual coppice types on unburned or burned areas for both moisture conditions.

Interspaces had significantly lower infiltration rates than tree and shrub coppices for all treatments, both moisture conditions. With the soil dry, interspace on the 1975 year-old burn had a significantly higher infiltration rate than interspaces on the unburned and recent burn treatments, and interspace on the 1974 year-old burn had a significantly higher infiltration rate than the unburned interspace.

Table 5. Mean infiltration rates (cm/hr) at the end of an hour-long, 8.38-cm/hr simulated rainstorm on coppice dune and dune interspace soils for unburned and burned treatments at middle White River, Nevada.

	Mean infiltration rate (cm/hr) for unburned and burned treatments							
	Soil dry				Soil at field capacity			
Stratification	Unburned	1975 Recent burn	1975 Year-old burn	1974 Year-old burn	Unburned	1975 Recent burn	1975 Year-old burn	1974 Year-old burn
Coppice types and interspace combined	7.34a[1/]	7.10a	7.47a	7.44a	6.65bc	5.85d	6.14cd	6.36cd
Coppice types combined	8.15a	7.91a	7.84a	7.97a	7.82a	6.68b	6.71b	7.07b
Tree and shrub coppice separate								
Tree coppice	8.28a	7.84a	8.13a	8.14a	8.22a	6.55cd	7.58ab	7.56ab
Shrub coppice	8.02a	7.97a	7.55ab	7.82a	7.42ab	6.81bc	5.83d	6.58cd
Coppice types and interspace separate								
Pinyon coppice	8.35a	7.66a-c	8.34a	8.01a	8.28a	6.10d-g	8.18a	7.06a-e
Juniper coppice	8.20a	8.01a	7.93ab	8.27a	8.17a	7.01a-e	6.97a-e	8.06a
Sagebrush coppice	7.90ab	7.89ab	7.70a-c	8.13a	7.22a-e	6.49b-g	5.54fg	6.81a-f
Bitterbrush coppice	8.13a	8.06a	7.41a-d	7.51a-d	7.63a-c	7.14a-e	6.16d-g	6.35c-g
Interspace	4.12hi	3.86i	5.97e-g	5.30gh	1.95k	2.51jk	3.85i	3.53ij

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[1/] Comparisons are made within rows for coppice types and interspace combined, and coppice types combined; and within rows and columns for tree and shrub coppice separate, and coppice types and interspace separate. Means followed by the same letter are not significantly different (0.05) as determined by Duncan's multiple range test.

In summary, infiltration rates on coppice dunes at field capacity were significantly decreased by burning. Shrub coppices had lower infiltration rates than tree coppices. Infiltration rates of shrub coppices decreased with the age of the burn, while those of tree coppices did not. Interspaces had significantly lower infiltration rates than coppices and interspaces on the year-old burns had a trend toward higher infiltration rates than interspaces on the unburned and recent burn treatments.

Sediment Production

Lower White River Site. With coppice and interspace combined and the soil at field capacity, recent and year-old burn treatments had significantly more sediment production than the unburned control (Table 6). With coppice alone, recent and year-old burn treatments produced significantly more sediment than the unburned treatment, both with the soil dry and at field capacity.

With the soil dry, tree coppice on the recent burn produced significantly more sediment than tree coppice on the unburned control. Shrub coppices produced significantly more sediment than tree coppices on burned and unburned treatments, both with the soil dry and at field capacity. Shrub coppice had significantly more sediment production on the year-old burn than the unburned treatment, for both moisture conditions. On unburned and burned areas, sediment production from sagebrush and bitterbrush coppices was similar, while pinyon and juniper coppices produced similar amounts of sediment.

In summary, burning increased sediment production from coppice dunes, and this effect was significant with the soil at field capacity. Tree coppices produced less sediment than shrub coppices on burned and unburned treatments. Sediment production from shrub coppices on burned treatments

Table 6. Mean sediment production (kg/ha) after an hour-long, 8.38-cm/hr simulated rainstorm on coppice dune and dune interspace soils for unburned and burned treatments at lower White River, Nevada.

	Mean sediment (kg/ha) for unburned and burned treatments					
	Soil dry			Soil at field capacity		
Stratification	Unburned	1975 Recent burn	1975 Year-old burn	Unburned	1975 Recent burn	1975 Year-old burn
Coppice types and interspace combined	203c[1]	379bc	378bc	223c	512ab	812a
Coppice types combined	140c	338ab	262a-c	157bc	456a	602a
Tree and shrub coppice separate						
Tree coppice	49e	181d	55e	50e	194d	190d
Shrub coppice	397cd	630bc	1,229ab	512b-d	1,046a-c	1,861a
Coppice types and interspace separate						
Pinyon coppice	82h-j	194e-h	86g-j	82h-j	223d-h	338c-h
Juniper coppice	30j	169f-i	36ij	29j	173f-i	106g-j
Sagebrush coppice	436b-h	675a-f	999a-e	456b-g	1,147a-d	1,621a-c
Bitterbrush coppice	354c-h	602a-f	1,513a-c	574a-f	954a-f	2,187ab
Interspace	932a-f	616a-f	1,697a-c	850a-f	870a-f	2,753a

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[1] Comparisons are made within rows for coppice types and interspace combined, and coppice types combined; and within rows and columns for tree and shrub coppice separate, and coppice types and interspace separate. Means followed by the same letter are not significantly different (0.05) as determined by Duncan's multiple range test.

tended to increase with burn age. Interspaces generaly had higher sediment production than coppices overall, but shrub coppices on burned treatments produced similar amounts as did interspaces.

Middle White River Site. With the soil dry and coppice and interspace combined, the recent and 1975 year-old burns had significantly more sediment production than the unburned control Table 7). With the soil at field capacity and coppice and interspace combined, all burned treatments had significantly more sediment production than the unburned treatment. With coppice alone, all burned treatments had signficantly more sediment production than the unburned control, both with the soil dry and at field capacity.

Sediment production from tree coppices was significantly higher on all burned than unburned treatments, for both moisture conditions. Shrub coppices had a trend toward higher sediment production than tree coppices overall. Shrub coppices on all burned treatments had a trend toward higher sediment production than unburned shrub coppices, both with the soil dry and at field capacity, though no significant differences occurred. Interspaces on burned treatments had a trend toward less sediment production than unburned interspace.

In summary, sediment production from tree coppices was significantly increased by burning. Overall, shrub coppices had a trend toward higher sediment production than tree coppices. Interspaces had a general trend toward higher sediment production than coppices, but coppice and interspace sediment production was more similar on burned than unburned treatments. Interspaces on burned treatments had a trend toward less sediment production than unburned interspace.

Table 7. Mean sediment production (kg/ha) after an hour-long, 8.38-cm/hr simulated rainstorm on coppice dune and dune interspace soils for unburned and burned treatments at middle White River, Nevada.

Stratification	Mean sediment (kg/ha) for unburned and burned treatments							
	Soil dry				Soil at field capacity			
	Unburned	1975 Recent burn	1975 Year-old burn	1974 Year-old burn	Unburned	1975 Recent burn	1975 Year-old burn	1974 Year-old burn
Coppice types and interspace combined	339e[1]	631b-d	759a-c	513c-e	407de	1,000ab	1,096a	741abc
Coppice types combined	240c	550b	724ab	501b	282c	813ab	1,072a	721b
Tree and shrub coppice separate								
Tree coppice	105d	389c	457bc	363c	98d	603bc	741a-c	513bc
Shrub coppice	537bc	794a-c	1,148ab	676a-c	813a-c	1,096ab	1,585a	1,023ab
Coppice types and interspace separate								
Pinyon coppice	129fg	575a-e	245eg	501b-e	117fg	1,090a-c	468b-e	525b-e
Juniper coppice	85g	257d-g	851a-e	263d-g	81g	331c-f	1,175a-c	490b-e
Sagebrush coppice	793a-e	1,095a-c	1,072a-c	676a-e	955a-d	1,202a-c	1,445ab	1,148a-c
Bitterbrush coppice	363b-f	562b-e	1,200a-c	692a-e	690a-e	1,000a-c	1,698ab	933a-e
Interspace	1,445ab	1,047a-c	977a-c	589a-e	1,820ab	2,188a	1,145a-c	794a-e

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[1] Comparisons are made within rows for coppice types and interspace combined, and coppice types combined; and within rows and columns for tree and shrub coppice separate, and coppice types and interspace separate. Means followed by the same letter are not significantly different (0.05) as determined by Duncan's multiple range test.

Influencing Factors

Correlation and regression analyses were used to determine independent variables influencing infiltration rates and sediment production. Equations built from coppice and interspace data combined would tend to contain variables related mainly to the differences between coppice and interspace. To help determine fire-related variables, infiltration and sediment equations were also constructed for coppice data only, and for tree and shrub coppice data separately. Simple correlation coefficients of determination were examined to find factors influencing interspace infiltration rates and sediment production. A list of dependent variables is in Appendix I . Independent variables are listed in Appendix J .

Infiltration

Infiltration regression equations for the lower and middle White River study sites are presented in Appendix K. Independent variables in these equations are ranked in order of importance for each dependent variable, with their standard partial regression coefficients in Table 8 .

Lower White River Site. With coppice and interspace combined, vesicular horizon development, bare ground, and 0-5 cm bulk density influenced infiltration rates most. Vesicular horizon development was the most important factor determining infiltration at both moisture conditions. Bare ground and 0-5 cm bulk density were of equal importance with the soil dry, but with the soil at field capacity, bare ground was twice as important as 0-5 cm bulk density and approached vesicular horizon development in importance.

Bare ground was the only independent variable in infiltration equations for coppice alone and tree and shrub coppice separate, both with the soil dry and at field capacity.

Table 8. Factors influencing infiltration rate dependent variables ranked in order of relative importance [1], as indicated by their accompanying standard partial regression coefficients, at lower and middle White River, Nevada.

Infiltration Rate Dependent Variables							
Soil dry				Soil at field capacity			
Coppice and interspace combined	Coppice	Tree coppice	Shrub coppice	Coppice and interspace combined	Coppice	Tree coppice	Shrub coppice
Lower White River site factors							
0.59[2]	0.24	0.31	0.09 [4]	0.70	0.45	0.56	0.22
Vesicular horizon development (-0.53) [3]	Bare ground (-0.49)	Bare ground (-0.35)	Bare ground (-0.30)	Vesicular horizon development (-0.44)	Bare ground (-0.67)	Bare ground (-0.76)	Bare ground (-0.48)
Bare ground (-0.18)				Bare ground (-0.38)			
0-5cm Bulk density (-0.17)				0-5cm Bulk density (-0.16)			
Middle White River site factors							
0.72	0.26	0.43	0.30	0.75	0.46	0.66	0.43
Vesicular horizon development (-0.69)	Bare ground (-0.36)	Surface soil moisture (-0.43)	Vesicular horizon development (-0.43)	Vesicular horizon development (-0.49)	Bare ground (-0.57)	Litter cover (0.67)	Bare ground (-0.39)
0-10cm Bulk density (-0.16)	Vesicular horizon development (-0.32)	Litter cover (0.36)	Bare ground (-0.33)	Litter cover (0.25)	Vesicular horizon development (-0.29)	0-10cm Bulk density (-0.33)	Vesicular horizon development (-0.23)
Litter cover (0.13)		Litter volume (0.24)		0-10cm Bulk density (-0.16)		Litter volume (0.21)	
				Organic matter (0.12)		Surface horizon sand fraction (0.20)	
				Litter volume (0.11)			

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[1] Read in columns by study site, most important factor listed first.

[2] Number above each column is the coefficient of determination (R^2) for that particular regression eqation.

[3] Standard partial regression coefficients are in parentheses.

[4] Significant at the 0.1 level. All other R^2 values are significant at the 0.01 level.

Vesicular horizon development was significantly ($P = 0.05$) negatively correlated ($R^2 = 0.25$) with interspace infiltration rates with the soil dry. No variables were significantly correlated with interspace infiltration rates with the soil at field capacity.

In summary, vesicular horizon development and bare ground were most important, and bulk density was of lesser importance in explaining variation of infiltration rates.

Middle White River Site. With coppice and interspace combined and the soil dry, vesicular horizon development was most important, and 0-10 cm bulk density and litter cover were equally of lesser importance as determinants of infiltration. With coppice and interspace combined and the soil at field capacity, vesicular horizon development, followed by litter cover was the most important, and 0-10 cm bulk density, organic matter, and litter volume were of lesser importance in explaining infiltration. Bare ground was more important in explaining coppice infiltration than vesicular horizon development for both moisture conditions. Surface soil moisture was most important, litter cover was intermediate in importance, and litter volume was least important in explaining tree coppice infiltration rates with the soil dry, while litter cover was most important, 0-10 cm bulk density and litter volume intermediate in importance, and sand fraction least important with the soil at field capacity. Vesicular horizon development was more important in explaining shrub coppice infiltration with the soil dry, while bare ground was more important with the soil at field capacity.

Sand fraction in the soil surface was significantly positively correlated ($R^2 = 0.30$) and clay and silt fractions in the soil surface horizon were significantly negatively correlated ($R^2 = 0.28$ and 0.16, respectively) with interspace infiltration rates on dry soil. Likewise, with the soil at field capacity, surface sand fraction was significantly ($P = 0.05$) positively correlated ($R^2 = 0.28$) and surface clay and silt fractions were significantly ($P = 0.05$) negatively correlated ($R^2 = 0.17$ and 0.22 respectively) with interspace infiltration rates.

In summary vesicular horizon development, litter cover, and bare ground accounted for the most variation in infiltration rates overall, while bulk density, organic matter, surface sand fraction, and soil moisture were of less importance.

Sediment Production

Sediment production regression equations for the lower and middle White River sites are presented in Appendix L . Independent variables in these equations are ranked in order of importance for each independent variable, with their standard partial regression coefficients, in Table 9 .

Lower White River Site. Bareground was more important than 0-5 cm bulk density and litter volume in explaining sediment production for both moisture conditions, with coppice and interspace combined. Litter cover was twice as important as 0-5 cm bulk density in explaining coppice sediment production with the soil dry, while bareground was most important, litter volume was intermediate in importance and 0-5 cm bulk density was least important with the soil at field capacity. Litter cover was the only variable explaining variation in sediment production from tree coppice at both moisture conditions. Bare ground was more important than 0-5 cm bulk density in explaining shrub coppice sediment production with the soil dry, and was the only important factor with the soil at field capacity.

Table 9. Factors influencing sediment production dependent variables ranked in order of relative importance [1], as indicated by their accompanying standard partial regression coefficients, at lower and middle White River, Nevada.

Sediment Production Dependent Variables							
Soil dry				Soil at field capacity			
Coppice and interspace combined	Coppice	Tree coppice	Shrub coppice	Coppice and interspace combined	Coppice	Tree coppice	Shrub coppice
Lower White River site factors							
0.49 [2]	0.40	0.08 [4]	0.43	0.54	0.54	0.30	0.24
Bare ground (0.45) [3]	Litter cover (-0.57)	Litter cover (-0.28)	Bare ground (0.71)	Bare ground (0.41)	Bare ground (0.47)	Bare ground (0.56)	Bare ground (0.49)
0-5cm Bulk density (0.17)	0-5cm Bulk density (0.23)		0-5cm Bulk density (0.41)	Litter volume (-0.37)	Litter volume (-0.25)		
Litter volume (-0.16)					0-5cm Bulk density (0.19)		
Middle White River site factors							
0.43	0.43	0.46	0.21	0.46	0.46	0.49	0.17 [5]
Litter volume (-0.34)	Bare ground (0.37)	Litter volume (-0.42)	Bare ground (0.52)	Litter volume (-0.43)	Litter volume (-0.41)	Bare ground (0.42)	Bare ground (0.34)
Bare ground (0.31)	Litter volume (-0.31)	Surface soil moisture (0.29)	Vesicular horizon development (0.39)	Bare ground (0.28)	Bare ground (0.32)	Litter volume (-0.34)	Vesicular horizon development (0.24)
Vesicular horizon development (0.16)	Vesicular horizon development (0.16)	Litter cover (-0.27)		Vesicular horizon development (0.11)	Vesicular horizon development (0.12)		

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[1] Read in columns by study site, most important variable listed first.

[2] Number above each column is the coefficient of determination (R^2) for that particular regression equation.

[3] Standard partial regression coefficients are in parentheses.

[4] Significant at the 0.1 level. All other R^2 values not subscripted are significant at the 0.01 level.

[5] Significant at the 0.05 level.

Silt fraction of the surface soil was significantly ($P = 0.05$) positively correlated with interspace sediment production with the soil dry ($R^2 = 0.45$), and with the soil at field capacity ($R^2 = 0.41$).

In summary, bareground and litter cover were most important and litter volume and bulk density were less important in accounting for variation in sediment production.

Middle White River Site. Litter volume was most important, bare ground was intermediate in importance, and vesicular horizon development was the least important in explaining sediment production with coppice and interspace combined, for both moisture conditions. Bareground was most important, with litter volume nearly equal in importance, and vesicular horizon development least important in explaining coppice sediment production with the soil dry, while with the soil at field capacity, litter volume was most important, bareground intermediate in importance, and vesicular horizon development least important. Litter volume was most important, with surface soil moisture and litter cover being nearly equally of lesser importance in explaining coppice sediment production with the soil dry, and bareground was more important than litter volume with the soil at field capacity. Bare ground was more important than vesicular horizon development in explaining shrub coppice sediment production for both moisture conditions.

Vesicular horizon development was significantly ($P = 0.05$) positively correlated ($R^2 = 0.26$) with sediment production from dune interspace with the soil dry. Vegetation cover was significantly ($P = 0.05$) positively correlated ($R^2 = 0.14$) with sediment production from interspace with the soil at field capacity.

In summary, bare ground and litter volume were most important in explaining variation in sediment production. Vesicular horizon development, litter cover, and soil moisture were less important.

DISCUSSION

Important variables in infiltration and sediment production regression equations reflect soil morphological or cover differences that could result from burning or could be the result of inherent, preburn differences between coppice and interspace areas, differences among coppice types, or differences among interspace areas. To find the effect of burning on important variables, analysis of variance and Duncan's multiple range test were used to determine differences among unburned and burned plots and areas for most independent variables in regression equations (Appendix M). Discussion of variables not in regression equations is based, in part, on their simple correlation coefficients.

Coppice and Interspace Relations

Dune interspace soils generally have lower infiltration rates and higher sediment production than coppice dune soils (Blackburn, 1975). This appears to be directly related to the amount of soil organic matter. Dune interspaces have less vegetation cover with less litter, and consequently less organic matter than coppice dunes. Low soil organic matter is associated with a higher bulk density and the formation of a platy to massive vesicular surface horizon (Wood, 1976), that slakes readily when wetted, and has a low infiltration rate and high sediment production (Blackburn, 1975). Infiltration and sediment production regression equations with coppice and interspace data combined reflected this phenomena. Vesicular horizon development, litter cover, litter volume, bare ground, and bulk density were consistently the variables most highly correlated with infiltration rates and sediment production (Tables 8 and9). Dune interspace plots had less litter cover and more bare ground, less organic matter, higher bulk density, and more vesicular horizon development than coppice plots (Appendix M).

Coppice Dune Relations

Soil temperature data recorded before, during, and after burning (Figure 8) suggest that burning would probably affect soil cover factors, but would be too cool (less than 50° C below 1 cm) to directly cause soil morphological changes. This is supported by coppice infiltration and sediment regression equations, where cover factors were consistently the most important variables (Tables 8 and 9).

Cover Factors

Either litter cover or bare ground appeared in every infiltration and sediment regression equation. Litter protects the soil surface structure and porosity from destruction by raindrop impact, allows higher infiltration rates, and reduces sediment production over a period of wetting. Since tree coppices generally had more litter cover and volume and less bare ground than shrub coppices (Appendix M , Tables 1, 2, 3), infiltration rates were higher and sediment production lower on tree coppice than on shrub coppice in unburned and burned areas.

Burning converts much of the coppice litter to light ash or charred fragments that are generally blown off of coppices by post-fire winds. Burned tree and shrub coppices had more of the characteristics associated with lower infiltration rates and higher sediment production (i.e., less litter cover and volume and more bare ground; see Appendix M, Tables 1, 2, 3) than did unburned tree and shrub coppices. Year-old burn coppices generally had less litter cover and volume and more bare ground than recent

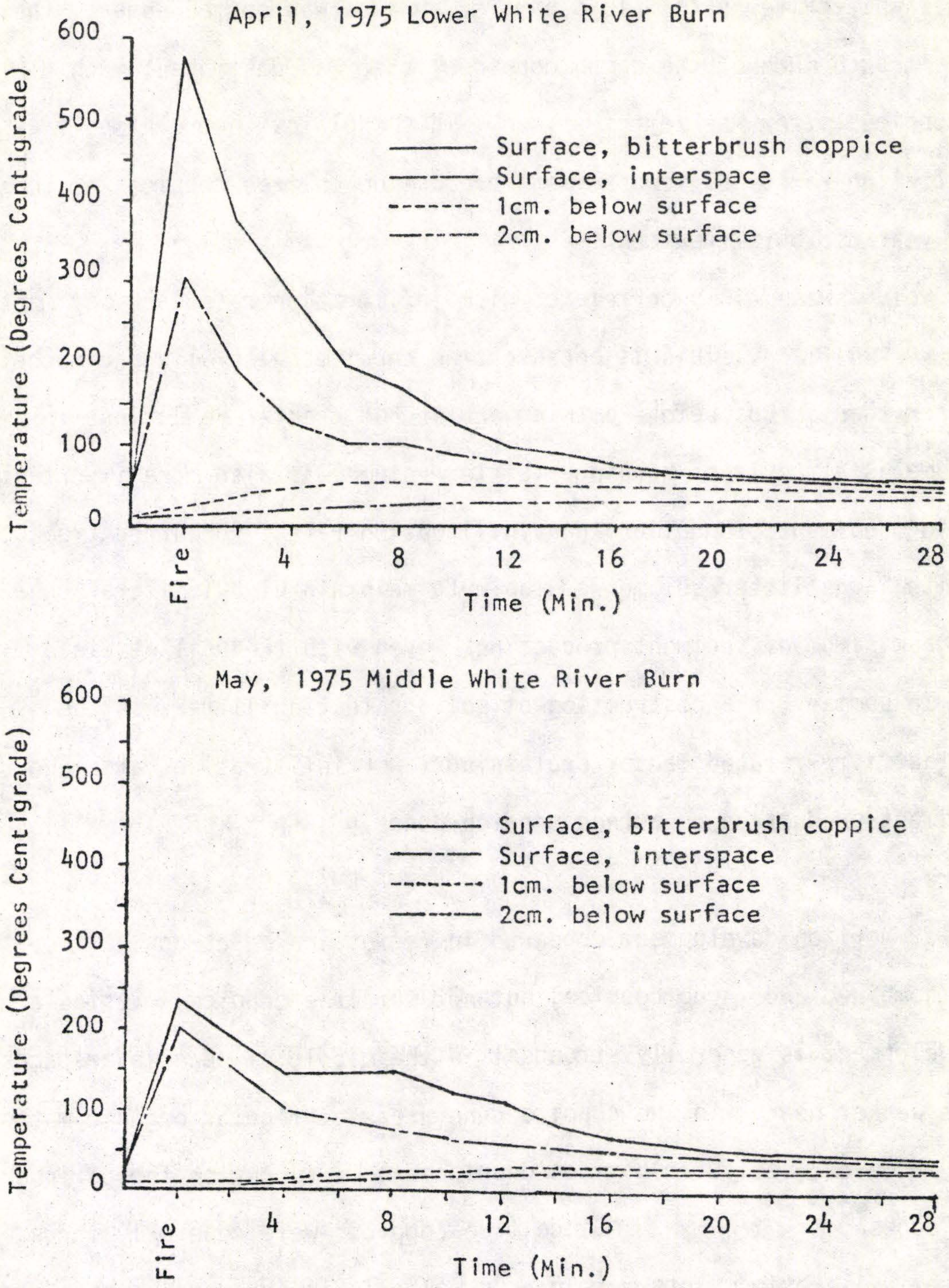

Figure 8. Mean temperatures from thermocouples at four positions during prescribed burns at lower and middle White River, Nevada.

burn coppices. One exception to this was tree coppices on the year-old burn at the lower White River site. This particular area was on the edge of the burn and, although much of the shrub coppice litter was destroyed, much of the tree coppice litter was left in place. This explains the relatively high infiltration rates and low sediment production on tree coppice for that particular year-old burn treatment.

Litter volume was mainly correlated with infiltration rates and sediment production on tree coppice. This is because tree coppices generally had much deeper litter than shrubs before burning and so had greater reductions in litter volume as a result of burning. Litter volume was also more important in explaining sediment production than infiltration rates. Unburned tree coppices with large litter volume were able to maintain high infiltration rates with a minimum of sediment production, even with the soil at field capacity. In summary, the destruction of soil-protecting litter was the most important fire-related factor explaining lower infiltration rates and higher sediment production on burned coppice dunes.

Soil Factors

Vesicular horizon development appeared in regression equations for coppice types combined and shrub coppice, but not for tree coppice. Vesicular horizon development is generally strongest in the middle of dune interspaces and becomes weaker nearer to the coppice dune areas of regular organic matter additions. However, vesicular horizon development may occur on the periphery of coppice dunes. Since tree coppices were generally large, tree coppice infiltration plots were placed well within the coppice area and rarely contained any peripheral vesicular horizon development. Shrub coppices were smaller and shrub coppice infiltration plots tended to contain some peripheral vesicular development. These characterisitics of shrub coppices explain, in part, the overall lower infiltration rates and higher sediment production on shrub coppices as compared to tree coppices. This suggests that runoff and sediment from coppice dunes will generally come from the periphery of the coppice dune.

Vesicular horizon development was not increased on burned coppice dunes (Appendix M, Table 4).

Organic matter binds soil particles into aggregates and expands the soil. It increases porosity and infiltration nad decreases vesicular horizon development (Blackburn, 1975). Organic matter in the upper 5 cm of coppice soil was generally not significantly different on unburned and year-old burn areas (Appendix M, Table 5). Only tree coppice on the 1975 year-old burn at the middle White River site had significantly less organic matter than tree coppice on the unburned area. However, organic matter values for coppice dunes on the year-old burns were slightly less than on the unburned areas.

Water-repellent soil investigations revealed a 1 to 2-cm thick water-repellent soil layer under the decayed litter of a few juniper trees and very few pinyon trees. This nonwettable layer had little effect on infiltration rates and sediment production on the soils in this study. In fact, percent water-repellent area was positively correlated with infiltration and negatively correlated with sediment production. A reason for this is that water-repellent areas were found on coppices with a large litter volume. Simulated rainfall was observed to infiltrate small wettable spots around the water-repellent areas and wet up the soil under water-repellent areas. Where fire destroyed most of the litter layer, any soil water-repellency at the soil surface was also destroyed. Water-repellent areas were much less extensive on burned than unburned coppices.

Bulk density of the coppice soil was negatively correlated with infiltration rates and positively correlated with sediment production. Bulk density of the upper 10 cm of soil was an important variable in relation to infiltration rate on tree coppice with the soil at field capacity at the middle White River site (Table 8). The importance of bulk density here was related to the fact that juniper coppices generally had lower bulk density in the surface 10 cm and higher infiltration rates than pinyon coppices in unburned and burned areas (Appendix M, Table 7). Bulk density in the upper 5 cm was also an important variable in coppice and shrub coppice sediment regression equations for the lower White River site. The importance of bulk density here is explained, in part, by the fact that shrub coppices had higher 0-5 cm bulk density and higher sediment production (due mainly to less litter cover) than tree coppices on unburned and burned areas.

Overall, bulk density was not increased by burning and its importance was related to natural variation among coppice dunes and not to burning.

Other factors included in coppice regression equations were surface sand fraction and initial surface soil moisture. Their importance is probably related to natural variation and is not due to burning.

Dune Interspace Relations

Differences among dune interspace infiltration rates and sediment production were mainly related to soil morphological differences. As was previously discussed, soil aggregation increases near the coppice dune areas of organic matter additions. Near the middle of dune interspaces, aggregation decreases and a platy to massive, low infiltration - high sediment-producing vesicular surface horizon is formed. The vesicular pores decrease in size and the vesicular horizon becomes thinner nearer to the coppice dune until it generally gives way abruptly to well-aggregated weak fine subangular blocky soil structure near the periphery of the coppice dune.

In areas of higher tree and shrub density, coppice dunes would be closer together and dune interspaces would be smaller and have more organic matter and less vesicular horizon development than dune interspaces in areas of less shrub and tree density. Thus the soil morphology and consequently the infiltration rate and sediment production of a particular dune interspace is related to its proximity to surrounding vegetation as an organic matter source.

Lower infiltration rates and higher sediment production on interspace on the year-old burn at the lower White River site were probably due to more vesicular horizon development (Appendix M, Table 4). This higher vesicular horizon development was probably due to the location of interspace plots with respect to coppice dunes and was unrelated to burning.

At the middle White River site, interspaces on the year-old burn had a trend toward higher infiltration rates and less sediment production than interspaces on the unburned and recent burn areas. Soil surface examinations showed that interspaces in the burned areas had less strongly developed and thinner vesicular horizons than interspaces in the unburned control. Line transect studies showed that the burned areas also had about 10% more coppice dune area than the unburned control. Evidently the unburned area had a lower density of the shrubs than the burned area, so the fire did not carry on the unburned area. Dune interspaces in the burned areas of higher coppice dune cover had more organic matter (Appendix M, Table 5), less vesicular horizon development, and more surface sand, due to the closer proximity to coppice dunes, than interspaces on the unburned area. This would account for the higher infiltration rates and lower sediment production of the interspaces on the 1975 and 1974 year-old burns. The soil surface morphology of the recent burn area was essentially the same as the year-old burn areas. The lower infiltration rate and higher sediment production on the recent burn were probably due to a higher initial soil moisture content, as a thundershower preceded the testing of this site. The results indicate that variations in infiltration rate and sediment production on interspaces were not caused by burning, but were the result of pre-burn differences in soil morphology andthe placement of interspace plots.

SUMMARY AND CONCLUSIONS

Soil infiltration rates and sediment production were studied on unburned, recent, and year-old prescribed burn treatments of pinyon-juniper communities near the White River in eastern Nevada. Simulated rainfall was applied at the rate of 8.38 cm/hr, for 1 hour to coppice dune and dune interspace areas, with the soil initially dry and at field capacity. Soil cover and morphological factors influencing infiltration and sediment production were investigated. Studies indicated the following:

1. Infiltration rates of coppice dune soil at field capacity were decreased by burning.
2. Infiltration rates tended to be lower on shrub coppice than on tree coppice and dune interspace had the lowest infiltration rates in unburned and burned areas. Generally, infiltration rates and sediment production were similar for pinyon and juniper coppices and were also similar for sagebrush and bitterbrush coppices.

3. Sediment production from tree coppice was significantly increased by burning. Sediment production from shrub coppice on burned areas was generally higher than on unburned areas. Shrub coppice had a trend toward higher sediment production than tree coppice overall.
4. On shrub coppice, infiltration rates tended to be lower and sediment production higher on year-old burns than the recent burn.
5. The destruction and loss of soil-protecting litter as a result of burning was the most important determinant of lower infiltration rates and higher sediment production on burned coppice dunes.
6. Surface bulk density and organic matter of coppice dunes were not significantly changed by burning. Burning did not increase vesicular horizon development on coppice dunes. Burning destroyed soil water-repellent areas occurring on juniper and pinyon coppices when most of the litter was consumed. There was no evidence of fire-intensified soil water-repellency.
7. Differences in infiltration rates and sediment production on dune interspaces were related to pre-burn soil morphological differences and probably were not the result of fire related soil changes.
8. Sediment production from raindrop splash will be higher on burned than unburned coppice dunes due to the absence of soil-protecting vegetation and litter cover, even if coppice infiltration rates are not exceeded. A thundershower of sufficient intensity and duration to exceed coppice dune infiltration rates on burned areas would produce much larger amounts of sediment. The associated increase in overland flow through dune interspaces would also increase erosion of coppice dunes. However, the soils studied were coarse

textured and had relatively high infiltration rates. Even after burning with the soil at field capacity, coppice infiltration rates were well above the 1-hour, 100-year return storm intensity of 3.4 cm/hr for the area (Miller, et al; 1975). Since most natural storms would be less intensity and duration than the simulated thunderstorm used in the study they would probably not exceed infiltration rates on burned coppiece dunes. Indications are that prescribed burning of similar areas will not substantially increase runoff and soil loss. Burning during the cool and wet times of the year will reduce the loss of coppice litter and help maintain high infiltration rates and low sediment production.

VEGETATION RESPONSE FOLLOWING PRESCRIBED BURNING IN THE PINYON-JUNIPER WOODLAND

The objective of this portion of the project was to determine the influence of fire on native vegetation. Five 1975 spring burns will be discussed as to their vegetative characteristics. The burns will be referred to as (1) April 24, (2) May 3, (3) May 9, (4) May 16, and (5) June 12.

METHODS

All field work was performed in the White River area of southern White Pine County, Nevada. Proposed burn areas were sampled prior to burning and sample plots were relocated and sampled in the spring (late May or early June) and in the fall (late July or early August) of 1975 and 1976.

Sample plots consisted of 31.62 meter square macroplots 100 meters apart (Fig. 9). Within each macroplot all trees were counted and recorded in 6 age classes defined a (1) seedling, (2) young saplings, (3) saplings, (4) vigorous mature, (5) old mature, and (6) decadent (Blackburn and Tueller, 1970).

A 30 meter line intercept dissecting the macroplot was used to measure percent cover of shrubs and trees. On the right side of this line intercept a series of 15 30 by 60 centimeter microplots was used to estimate foliage projection of forbs and basal area of grasses. Ground cover was estimated using the four corner points of the microplot and each observation was recorded as either litter, bareground, rock greater than 2", erosion pavement 1/4-2", or live vegetation.

Along the line intercept, individual plants, primarily rabbitbrush (*Chrysothamnus* sp.) and desert bitterbrush (*Purshia glandulosa*), were permanently marked and recorded on a grid noting age classes. Criterion for determining age classes for these plants were the same used for the tree census.

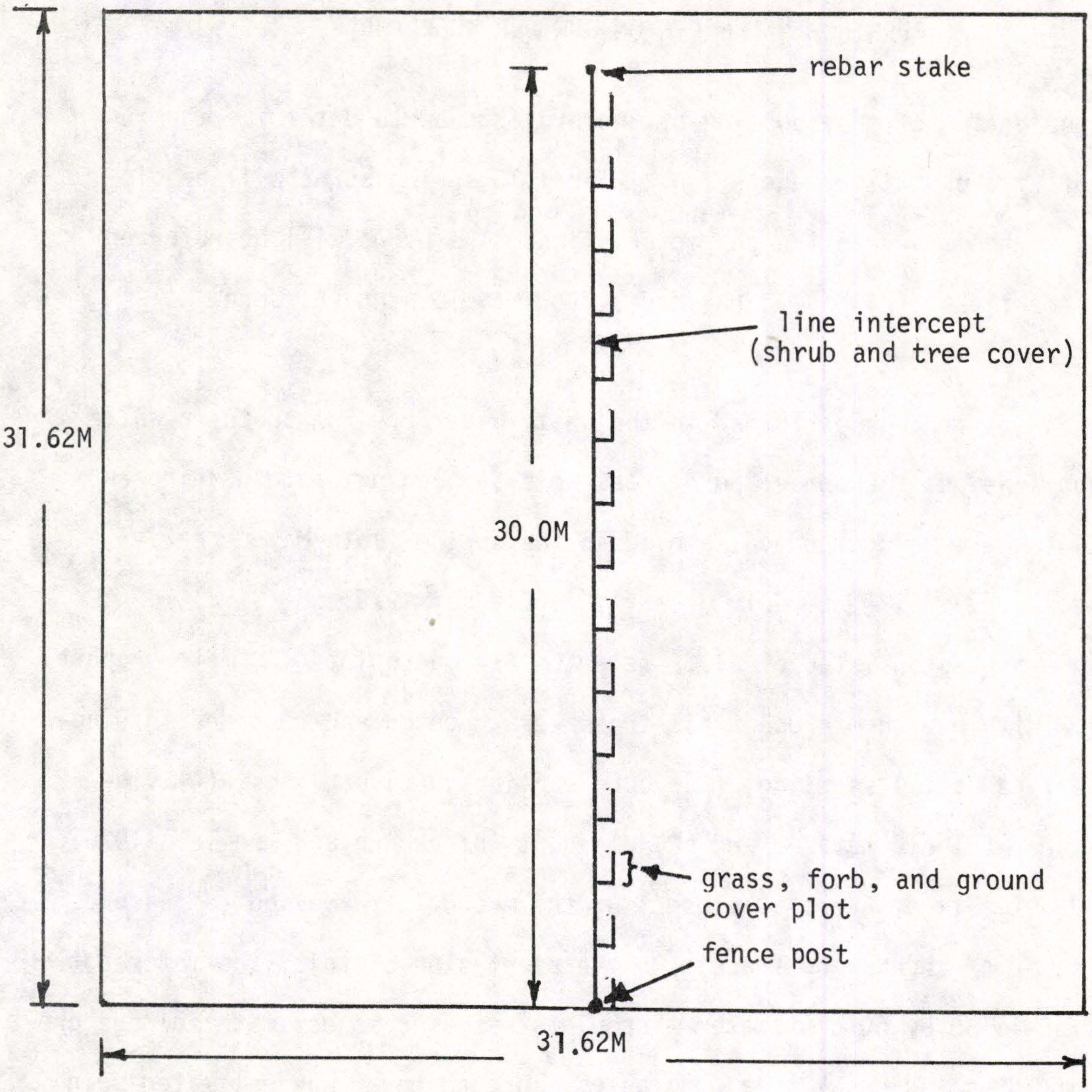
rebar stake
line intercept
(shrub and tree cover)
31.62M
30.0M
grass, forb, and ground cover plot
fence post
31.62M

Figure 9. One-tenth hectare square plot used for sampling vegetation on all sites.

In the spring of 1975 a flush of germinating bitterbrush rodent cashes were observed on burns 1 and 2. Sample plots were randomly located to determine the significance of caches inside the burns versus outside the burns and to describ the cache locations in relation to coppice dunes and interspaces. The sample plots were belt transects 25 meters long by 2 meters wide providing 50 1 square meter subplots per transect. 10 plots were located inside burn 1 and 15 plots were located inside burn 2. A series of 5 plots were established to determine rodent cache number outside each burn.

RESULTS

Preburn Cover

Generally, all sites were dominated by live and dead sagebrush (*Artemisia tridentata*) and live and dead desert bitterbrush with rabbitbrush, currant (*Ribes* sp.), and serviceberry (*Amelanchier alnifolia*) present in small amounts (Table 10). Burn 1 had the largest total shrub cover with 56% followed by burn 2 (48%), burn 4 (37%), burn 3 (27%), and burn 5 (23%).

Tree cover, including both pinyon and juniper, varied from 29% on burn 3 to 6% on burn 1. Age class distribution of the trees (Table 11) show most trees in age classes 3 and 4 suggesting invasion occurred 50-100 years ago.

Estimated forb cover in the areas was sparse and ranged from 0% on burn 1 to .3% on burn 5 (Table 10). Forbs encountered included cryptantha (*Cryptantha* sp.), eriogonum (*Eriogonum maculatum*), prickly pear (*Opuntia* sp.), penstemon (*Penstemon* sp.), and thorn skeletonplant (*Lygodesmia spinosa*).

Grasses were also sparse with percent cover ranging from 0 to burn 1 and 2 to .3 on burn 4. Grasses encountered include Great Basin wildrye (*Elymus cinereus*), Sandberg's bluegrass (*Poa sandbergii*), bottlebrush squirreltail (*Sitanion hystrix*), and sub-alpine needlegrass (*Stipa columbiana*).

Table 10. Mean percent cover of shrubs, trees, forbs, and grasses prior to burning on five burn sites in the White River area.

	Burn Number				
	1	2	3	4	5
Shrubs					
Artemisia tridentata dead	5a[1]	7a	2a	8a	3a
Artemisia tridentata live	20a	18a	3b	16a	9b
Purshia glandulosa dead	10ab	1c	13a	3bc	1c
Purshia glandulosa live	18a	20a	9a	9a	10a
Chrysothamnus viscidiflorus dead	2a	0a	0a	0a	0a
Chrysothamnus viscidiflorus live	0b	2a	Tb[2]	1b	Tb
Chrysothamnus nauseous	1a	0a	0a	0a	0a
Ribes sp.	0a	0a	Ta	0a	Ta
Amelanchier alnifolia	0a	0a	0a	Ta	0a
Total dead shrub	17	8	15	11	4
Total live shrub	39	42	15	26	19
Total live and dead shrub	56	50	30	37	23
Trees					
Pinus monophylla	2c	6bc	18a	11ab	6bc
Juniperus osteosperma	4a	2a	11a	3a	9a
Total tree	6	8	29	14	15
Forbs					
Cryptanthus sp.	0	0	0	T	T
Eriogonum maculatum	0	0	0	0	T
Opuntia sp.	0	T	0	0	.2
Penstemon sp.	0	0	0	0	T
Lygodesmia spinosa	0	T	0	.1	0
Total Forb	0	T	0	.1	.3
Grasses					
Elymus cinereus	0	0	T	T	0
Oryzopsis hymenoides	0	0	0	.1	T
Poa sanbergii	0	0	0	.1	T
Sitanion hystrix	0	0	0	.1	.2
Stipa columbiana	0	0	0	0	T
Total Grass	0	0	T	.3	.2

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[1] Means with the same letter are not significantly different (P = .05).

[2] T = less than .5% for shrubs and less than .05% for forb and grass.

Table 11. Number of trees in each age class per hectare prior to burning on five burn sites in the White River area of White Pine Mountains, Nevada.

Species	Age Class[1]	Burn Number 1 04/24/75	2 05/03/75	3 05/09/75	4 05/16/75	5 06/12/75
Pinyon	1	6[2] b	27 b	6 b	14 b	64 a
	2	10 b	70 a	2 b	76 a	64 a
	3	90 b	227 a	88 b	108 b	74 b
	4	20 b	13 b	190 a	162 a	76 b
	5	3 b	3 b	98 a	8 b	12 b
	6	0 a	0 a	8 a	0 a	2 a
Total		129	340	392	368	292
Juniper	1	3 a	13 a	0 a	16 a	48 a
	2	6 b	23 b	6 b	104 a	146 a
	3	60 bc	213 a	44 c	88 bc	164 ab
	4	13 c	30 c	136 ab	78 bc	178 a
	5	0 a	3 a	12 a	0 a	14 a
	6	3 a	0 a	4 a	4 a	2 a
Total		85	282	202	290	552
Total for Pimo and Juos		215	622	594	658	844

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[1] 1 = seedling, 2 = young sapling, 3 = sapling, 4 = vigorous and mature, 5 = mature and old, and 6 = decadent.

[2] Numbers with the same letters are not significantly different (p = .05)

Shrub Cover

Refer to Appendix N for the composition of shrub cover on each burn. Burning completely removed pinyon and juniper from the areas. This was to be expected since it is generally accepted that fire eliminates non-sprouting species (Blaisdell, 1953). Some trees near the edge of the burn were only partially burnt and some of these survived through the second year. This supports Dwyer and Pieper (1967) who observed trees with less than 50% of the foliage burned recovered. Several pinyon seedlings were observed on the burns the first spring, but were not evident the second year.

On all areas, total shrub cover was significantly lower after burning due to the elimination of non-sprouting sagebrush. Observations tend to support Blaisdell (1953) who stated that invasion is slow for sagebrush depending on the nearness of the seed source. Sagebrush seedlings were observed near the edges of burns 1 and 2.

Little green rabbitbrush cover increased slightly, though not significantly, by the second year as compared to preburn cover (Table12). By observing marked plants, percent resprout of little green rabbitbrush averaged 57% with higher resprout percentages occurring in older age classes (Table13).

The impact of sprouting rabbitbrush on the community as succession advances cannot be determined from this study due to the lack of sufficient time. However, most literature suggests that rabbitbrush will become very important. According to Young and Evans (1974) rabbitbrush continues to dominate and periodically reestablishes itself for at least 15 years following burning. Reduced populations of rabbitbrush persisted in the sagebrush communities where dominant big sagebrush plants are 40-50 years old. Seed production and seedling establishment on the burn areas will be important factors to consider in determining the importance of rabbitbrush in the community.

Table 12. Shrub Cover prior to burning and in the spring and fall of 1975 and 1976 for all burns.

Burn No.	Preburn Total[1]	Rootsprouters	S.1975	F.1975	S.1976	F.1976
1	39a[2]	1b	Tb[3]	Tb	1b	1b
2	42a	2b	Tb	4b	4b	4b
3	15a	Tb[4]	0b	0b	Tb	Tb
4	26a	1b	Tb	Tb	1b	2b
5	19a	Tb	0b	0b	0b	0b

[1] Total live shrubs including non-sprouting species.
[2] Row means with the same letter are not significantly different (P= .05).
[3] All post-burn shrubs are root-sprouting shrubs.
[4] T is less than .5% cover.

Table 13. Response of marked plants in the fall of 1975 and 1976.

Species	Age Class	Number Marked	1975		1976	
			Number Resprout	Percent Survival	Number Resprout	Percent Survival
Purshia glandulosa	2	18	0	0	0	0
	3	18	0	0	0	0
	4	31	2	6	0	0
	5	18	0	0	0	0
Total		85	2	2	0	0
Chrysothamnus viscidiflorus	2	4	1	25	1	25
	3	3	2	67	2	67
	4	3	2	67	2	67
	5	4	3	75	3	75
Total		14	8	57	8	57

A different response was observed for bitterbrush. Of 85 plants marked only two resprouted during the first growing season. The sprouts were located approximately 2 inches above the soil surface and lacked apparent vigor. In the second growing season both resprouts died. No plants resprouted in the second year.

The lack of resprouting desert bitterbrush does not support the majority of the literature. Aro (1971) stated that desert bitterbrush tolerates burning in the pinyon-juniper woodland. Results from collected data show it might have weak resprouts in the first year, but by the second year no resprouts are evident. Wright (1972) stated that it resprouts in southern California. Differences in climatic and edaphic conditions between the White River area and southern California might explain this difference.

Although living bitterbrush plants were killed, the presence of rodent caches in some of the burns suggests that the species recovers and becomes an important constituent of the area as succession advances.

In the spring of 1975,bitterbrush seedlings germinating from rodent caches were observed on burns 1 and 2. Later in the spring of 1976 rodent caches were found in lower densities on burn 3. On burns 1 and 2 there were significantly more rodent caches inside the burns than outside the burns (Table 14). Burns 3, 4, and 5 were not sampled due to low cache densities.

Rodent cache mortality from the spring of 1975 to the fall of 1976 ranged from 12 percent inside burn 1 to 2 percent inside burn 2. Mortality in most cases appeared to be the result of damage by deer and small mammals. Numbers of rodent caches in the fall of 1976 were not significantly lower than in the spring of 1975. In plots located outside the burns no mortality was found for rodent caches in either burn area. No bitterbrush caches germinated between the spring of 1975 and the fall of 1976.

Table 14. Rodent cache densities per 50 square meters and mortality for Burns 1 and 2 in 1975 and 1976.

Location	Density		Percent Mortality
	1975	1976	
BURN 1			
Inside	8.4a[1]	7.4a	12
Outside	1.8b	1.8b	0
BURN 2			
Inside	23.8a	23.3a	2
Outside	3.2b	3.2b	0

[1] For each burn means with the same letter are not significantly different (P = .05)

Table 15. Rodent cache location on burns 1 and 2 expressed as a percent of the total caches.

	Pinyon Coppice	Juniper Coppice	Sagebrush Coppice	Bitterbrush Coppice	Rabbitbrush Coppice	Inter-Space
Burn 1	40.4a[1]	0 c	26.9ab	26.9ab	0 c	5.8bc
Burn 2	8.8b	11.7b	33.9a	41.0a	3.5b	1.1b

[1] Row means with the same letter are not significantly different (P = .05).

On burn 1 there were significantly more (P = .05) caches located on pinyon coppices than on juniper and rabbitbrush coppices or inter-spaces (Table 15). Sagebrush and bitterbrush coppices had significantly more caches than juniper or green rabbitbrush coppices. On burn 2 there were significantly more caches on sagebrush and bitterbrush coppices than in the interspaces or on pinyon, juniper, and rabbitbrush coppices. These differences imply that either pinyon, sagebrush, and bitterbrush coppices are better germination sites for bitterbrush seedlings or rodents prefer these coppices to cache their seeds.

A significant correlation (P = .05) exists, however, between numbers of rodent caches in the shrub coppices and percent cover of the shrub species. The formula for the regression equation is: $Y = .903 + 2.571X$ where Y is the number of rodent caches and X is the percent of the total shrub cover of each individual shrub species. This regression implies that when rodent caches germinate, their locations are a function of total shrub cover rather than cover of any particular shrub if adequate seed sources are present from existing bitterbrush plants. The significant differences in numbers of rodent caches in respective coppice dunes and interspaces can be explained to a certain extent by shrub and tree cover differences in preburn vegetation.

West (1968) stated that rodent-cached bitterbrush seeds frequently result in establishment of seedling clusters in montane forests of central Oregon. Sanderson (1962) noted that bitterbrush seedlings are scarce in northeastern California, but in the spring of 1960 a large flush of seedlings emerged from seed in rodent caches. Seedlings that had to compete with the native vegetation and cheatgrass failed to survive, but where competing vegetation had been removed, survival was excellent. On the White River burns competing vegetation, primarily forbs, did not significantly affect rodent cache densities. As to the reason for the abundance of caches inside the burns, an edaphic or microenvironmental change occurred resulting in germination of rodent caches. Additional research could help explain this phenomenon.

Grass Cover

Refer to Appendix N for composition of grass cover on each burn. Slight increases in grass cover from preburn cover to postburn cover was noted on burns 2, 3, and 5 (Table 16). No grasses were encountered on burn 1 at any time. On burn 4 grass cover decreased from .3% prior to ignition to .1% in the fall of the second year. No significant difference in grass cover was noted on any of the areas due to the relative lack of grasses on the areas originally.

Although no firm conclusions can be drawn regarding perennial grass response from this study, some grasses, including Indian ricegrass (*Oryzopsis hymenoides*) and Great Basin wildrye (*Elymus cinereus*) were not eliminated by fire.

Table 16. Total grass cover in the spring and fall of 1975 and 1976 for all burns. No significant differences were noted.

	Percent Cover				
Burn #	Preburn	Sp.1975	F.1975	Sp.1976	F.1976
1	0	0	0	0	0
2	0	0	0	.4	.8
3	T	0	.1	.6	.5
4	.3	0	0	0	.1
5	.3	.3	.2	.7	.9

Ground Cover

Important but expected changes occur from preburn ground cover to postburn ground cover (Table 17). The most obvious change is a shift from primarily litter in preburn ground cover to bareground after burning. Litter during the spring of the first year was composed almost entirely of ash, particularly on pinyon and juniper coppices. Litter in the fall of the first year decreased slightly due to the loss of ash from wind action. In the second year, litter increased and then remained stable with the loss of ash and the addition of other litter from the previous year's forb cover. Bareground showed an increase from the spring of 1975 to the fall due to wind action, and decreased during 1976 due to increased litter and live vegetation. Erosion pavements decreased gradually through 1976.

There was significantly less live vegetation ground cover in the spring of 1975 than in the spring and fall of 1976 and the preburn live vegetation ground cover.

Table 17. Mean Ground Cover for all burns combined in the spring and fall of 1975 and 1976.

Cover Type	Preburn	Sp.1975	F.1975	Sp.1976	F.1976
Litter	69.9a[1]	17.7b	15.9b	21.6b	21.6b
Bareground	20.2a	69.8b	73.0b	66.8b	67.9b
Rock	1.7aa	1.9a	1.8a	1.9a	1.0a
Pavement	2.2a	10.2a	6.6a	4.4a	1.0a
Live Vegetation	6.0a	.3b	3.7ab	5.3a	8.5a

[1] Row means with the same letter are not significantly different (P = .05)

The significant increase in bareground on burned areas suggest an increase in erosion potential and sediment production. Roundy (1976) states that the destruction and loss of soil-protecting litter as a result of burning was the most important determinant of lower infiltration rates and higher sediment production on burned coppice dunes. However, few natural storms would be sufficient in intensity to cause substantial overland flow with the accompanying sediment production.

Forb Cover

Refer to Appendix N for composition of forb cover on each burn. Increases in forb cover were the most important aspect of succession following burning. Significant differences in total forb cover between burned areas were noted in the spring and fall of 1976, but no significant differences occurred between sites in 1975.

Forb cover an all burns increased from the spring of 1975 to the fall of 1976 with the most significant increases occurring in the second year. Germinating seeds from the forbs present in the first year and invading forb species account for the increase in the second year. By the spring of 1976 forb cover was significantly higher than preburn forb cover on all burns.

A comparison of total forb cover between burns revealed significant differences in the second year (Table 18). In the spring of the second year, burn 1 had significantly more forb cover than burn 4. In the fall burns 1, 2 and 3 had significantly more forb cover than burns 4 and 5.

Table 18 Total forb cover in the spring and fall of 1975 and 1976 for all burns.

	Percent Cover				
Burn #	Preburn	Spring 75	Fall 75	Spring 76	Fall 76
1	0 c	.2cA[1/]	1.6cA	7.6bA	14.8aA
2	T c	0 cA	.8cA	5.7bAB	13.5aA
3	0 c	.2cA	1.0cA	2.9bAB	11.4aA
4	.1c	.3cA	1.8bcA	2.7bB	7.8aB
5	.3b	0 bA	.8bA	3.2aAB	3.6aB

[1/] Column means with same upper case letters are not significant (P = .05)
Row means with same lower case letters are not significant (P = .05)

To determine the importance of forb species in the postburn communities, importance values similar to those used by Brown and Curtiss (1952) were used. The importance value was derived by the sum of the percent relative cover and percent frequency for each forb.

The importance values of forbs for the burns combined showed changes in importance of forb species as succession advanced. Skeletonplant (Lygodesmia spinosa), lupine (Lupinus sp.) and coyote tobacco (Nicotiana attenuata) were the three most important forbs in the spring of the first year. Scarlet globemallow (Sphaeralcea coccinea), skeletonplant, and prickly poppy (Argemone platyceras) were most important in the fall. In the spring of the second year coyote tabacco, scarlet globemallow, and groundsmoke (Gayophytum ramosissimum) were most important. In the fall coyote tobacco was still the most important forb but groundsmoke and skeletonplant increased to become the second and third most important species (Table 19).

When the importance values are combined from all seasons and all burns, coyote tobacco, globemallow and groundsmoke become the three most important forbs followed in descending order by skeletonplant, lambs-quarters goosefoot (*Chenopodium album*), gilia (*Gilia* sp.), lupine, prickly poppy, and astragalas (*Astragalas* sp.).

The importance of any forb species on the burns is dependent on its ability to increase rapidly the second year through germination of seeds left by plants from the previous year. Coyote tobacco, scarlet globemallow, and groundsmoke are capable of quickly invading burned areas and a good seed source is available for germination in the second year.

Table 19. Overall importance values of the eight most important forbs in each season and mean importance values for all burns and seasons combined.

Species	Sp.1975	F.1975	Sp.1976	F.1976	Mean for all Seasons
Argemone platyceras	.3	14.8	10.6	16.8	10.6
Nicotiana attenuata	5.8	11.8	47.4	55.8	30.2
Chenopodium album	5.3	4.8	17.8	19.8	11.9
Gayophytum remossissimum	5.3	0	24.7	43.3	18.3
Lygodesmia spinosa	16.7	16.9	16.1	20.4	17.5
Lupinus sp.	10.9	5.8	12.1	14.1	10.7
Gilia sp.	0	11.7	20.7	10.7	10.8
Sphaeralcea coccinea	0	58.4	26.2	14.9	24.9

To determine the similarity in forb communities for each season for each burn, a coefficient of community, defined as the number of species common to the area expressed as a percentage, was used (Greig-Smith, 1964). These coefficients of community show differences in floristic composition for the burned areas (Table 20). Coefficients during the spring and fall of the first year showed little similarity of composition. In the spring only burns 2 and 3 showed any similarity. In the fall all areas showed some similarity except burn 4 as compared to burn 5. The highest coefficients occurred between burns 1, 2, and 3.

The majority of the coefficients in the spring and fall of 1976 were notably higher, particularly for burns 1, 2, and 3. Most of the coefficients were the highest in the fall.

The coefficients of community are useful in comparisons between two areas, but cannot be used to compare 2 or more areas. For this reason, an index of biotal dispersity was used to determine similarity in floristic composition for the burns combined for every season (Greig-Smith, 1964). This index increased from the spring of 1975 through the fall of 1976, suggesting a trend toward similarity as succession advances (Table 20).

Whether or not all areas will become homogeneous in floristic composition as succession advances cannot be predicted, but the trend in the first two years tend to support this hypothesis. However, differences in total forb cover tend to suggest that site differences or individual burn characteristics cause differences in the amount of forb cover. Probably most important in determining forb cover is the time of burning since the earlier burns had more forb cover than the later burns. Also, the most important forbs on each burn varied, suggesting that some burn areas provided a better environment for certain forb species.

Table 20. Comparisons of coefficients of communities and indices of biotal dispersity for all burns in all seasons.

	Spring 1975						Fall 1975				
Burn	1	2	3	4	5	Burn	1	2	3	4	5
1	100	0	16.7	0	0	1	100	11.1	22.2	11.1	12.5
2	0	100	0	0	0	2	11.1	100	40.0	20.0	25.0
3	16.7	0	100	0	0	3	22.2	40.0	100	16.7	20
4	0	0	0	100	0	4	11.1	20.0	16.7	100	0
5	0	0	0	0	100	5	12.5	25.0	20.0	0	100

Index of biotal dispersity = 3.1

Index of biotal dispersity = 18.2

	Spring 1976						Fall 1976				
Burn	1	2	3	4	5	Burn	1	2	3	4	5
1	100	38.5	58.3	16.7	16.7	1	100	30.8	50.0	15.4	7.7
2	38.5	100	54.6	33.3	33.3	2	30.8	100	41.7	40.0	40.0
3	58.3	54.6	100	18.2	30.0	3	50.0	41.7	100	36.4	36.4
4	16.7	33.3	18.2	100	33.3	4	15.4	40.0	36.4	100	33.3
5	16.7	33.3	30.0	33.3	100	5	7.7	40.0	36.4	33.3	100

Index of biotal dispersity = 33.3

Index of biotal dispersity = 38.3

Increases in forbs following burning have been observed by many authors (Mueggler and Blaisdell, 1958; Wright, 1969). These increases have been explained in many ways including increased nutrients from ash (Lewis and Hart, 1972; Wright, 1969; Ahlgren and Ahlgren, 1960; Dwyer and Pieper, 1967) and a combination of nutrients from the ash and soil moisture and relative humidity (Wink and Wright, 1973). Undoubtedly, increased availability of nutrients, particularly nitrogen, is important to growth of forbs and account for some of the increase. Decreased competition from perennial species following a burn benefit the forbs also.

My results suggest the season of burning is important in determining the amount of forb cover. The earlier the burn, the more forb cover. However, it should be noted that soil moisture and relative humidity was higher for the earlier burns. Increased nutrients on the burns are important, but the amount of forbs which can utilize these nutrients appears to be determined by climatic and edaphic conditions such as soil moisture at the time of burning and directly after.

The forb communities can be useful to wildlife species by creating a different habitat. Bird diversity and numbers increased on burned areas in the White River area (Mason, 1976).

CONCLUSIONS

Several conclusions can be made regarding vegetation response on the burns. It should be noted that these conclusions are based on vegetation response in the White River area and responses may differ in other areas.

1. All non-sprouting species including sagebrush, pinyon and juniper are eliminated.
2. Bitterbrush resprouts occasionally, but sprouts die by the second year.
3. Rodent-cached bitterbrush seedlings may be present on the burn with more seedlings present on earlier burns.
4. Rabbitbrush neither increased nor decreased significantly after burning due to the relative low abundance in the preburn vegetation.
5. No significant difference in grass cover was noted but Great Basin wildrye and Indian ricegrass were not eliminated by fire.
6. Forb cover accounted for most of the post-burn cover and increased significantly by the spring of the second year as compared to the first year and preburn cover.
7. Earlier burns had more forb cover than later burns.
8. Relative importance of forbs varied between burns and seasons but overall, Coyote tobacco, scarlet globemallow, and groundsmoke were the most important.
9. The trend is toward similarity of floristic composition as succession advances.

BIG GAME RESPONSE TO SUCCESSFUL CHANGES IN PINYON-JUNIPER AFTER WILDFIRE

INTRODUCTION

Pinyon and juniper invasion of shrub/bunchgrass communities decrease deer range productivity by crowding out forage plants. Fire can be effective in controlling pinyon-juniper and maintaining ranges in a productive condition for mule deer (Odocoileus hemionus).

In using fire as a management tool it is necessary to be able to predict both plant and animal responses to its use. The responses will be different on different areas due to various factors. The objectives of this study are to investigate wildfires to evaluate:

1. The vegetation response and duration of pinyon-juniper successional stages in various areas after wildfires.
2. The conditions necessary for mule deer response to fire in pinyon-juniper communities.

LITERATURE REVIEW

In the Great Basin, food is often the limiting factor on mule deer herd size (Dasmann 1971). Food preferences of mule deer change with the season of the year, growth stages of the plants, and the changing composition of the plant cover. As forbs and grasses cure, browse becomes increasingly important in a deer's diet. During the winter bitterbrush, mountain mahogany (Cercocarpus sp.), sagebrush and juniper are of major importance to deer (Doughty 1966; Diebert 1968; Dasmann 1971). Other important browse plants are Ceanothus sp., manzanita (Arctostaphylos sp.), snowbrush (Symphoricarpus sp.), service berry (Amelanchier sp.), desert peach (Prunus sp.), and wild rose (Rosa sp.)(Leach 1956).

As snow melts and greenup occurs, deer switch to succulent, new growth. The timing of this switch is dependent on snow conditions and precipitation patterns during the spring. Later in spring and early summer, forbs become important in the diet. They remain important as long as they are available. But as browse plants produce new growth, forb use decreases (Doughty 1966; Diebert 1968; Dasmann 1971; Constan 1972).

The best deer ranges usually contain mixtures of rather diverse plant communities (Dasmann 1971; Tueller and Monroe 1975). The vegetation preferred by deer usually occurs in the sub-climax stages of woodland communities (Leopold 1950; Miller 1963; Tausch 1973).

Pinyon-juniper expansion has mainly been into sagebrush/grass communities which supply important forage species for mule deer (Aro 1971; Barney and Frischknect 1974; Beeson 1974). As tree cover becomes dominant in these communities the forb, grass, and shrub species are crowded out (Blackburn 1967; Lyon 1969; Clary 1971; Tausch 1973; Barney and Frischknect 1974). Fire can be used as a management tool to keep parts of this woodland in a subclimax condition Leopold 1950; Dasmann 1951; Miller 1963; Hendricks 1968; McCulloch 1969; Wright 1974).

Arnold, et al. (1964) found that the first plants to come back in Arizona, after a wildfire in pinyon-juniper, were annuals. The annuals were usually most abundant in the second growing season. Perennial forbs ahd halfshrubs replaced the annuals after the fourth to sixth growing season. The perennial grasses became established by the fourth season and increased to the sixth. If shrubs were present a perennial shrub stage developed. If no shrubs were present a perennial shrub stage developed. If no shrubs were present a perennial grass community developed. Eventually both communities were reinvaded by trees if protected from fire.

A study on successional stages after wildfires in Utah showed a similar response but slightly different time periods. The annuals reached a maximum development in the third to fourth years and were replaced by a perennial grass-forb stage by the fifth to sixth year. If shrubs were dominant to grasses before the burn, then shrubs would replace the annuals. On most sites shrubs did not become dominant for approximately seventy years but started coming back within eleven years (Barney and Frischknect 1974).

The above authors listed factors that they felt affected the vegetation changes after a burn. A young stand of pinyon-juniper would be slower to reinvade than a more mature stand since there would be no seed producing trees for a number of years. Succession would also be slower if reinvasion occurred only from the burn edge and not from seed producing trees left by the fire. Finally, heavy grazing after a fire would increase the rate at which shrubby species would invade the site.

Generally, as pinyon-juniper cover is decreased, understory vegetation production increases which increases forage available for wildlife (O'Rourke and Ogden 1969; Jensen 1972; Tausch 1973; Wright 1974). Even before this increase occurs deer have been known to concentrate on burns. Komarek (1969) observed white-tailed deer (Odocoileus virginianus) nibbling ash on a control burn site. The ash was high in calcium, potash, and trace minerals.

The absence of cover, its sparseness or poor distribution can limit the use of an area by wildlife (Yoakum 1971). Cover provides shelter from the elements, increases chances of escape from enemies, and fosters a sense of security. By creating openings in dense cover, the number of deer on an existing range can be increased (Dasmann 1971).

McCulloch (1969) theorized that small burns, among unburned woodland, would create greater variety of cover and food than that available on large areas, either burned or unburned. Many authors have found that deer use of an area is related to available cover. Deer use on burns and chainings is greatest near cover and decreases away from it (Loveless 1963; Cole 1968; Tausch 1973; Tueller and Monroe 1975). Because of this, small patchy burns are recommended over large uniform burns for deer habitat (Cole 1968; Hendricks 1968; Wright 1974). McCulloch (1969) suggested that the optimum width of a burn may be less than 1/4 mile.

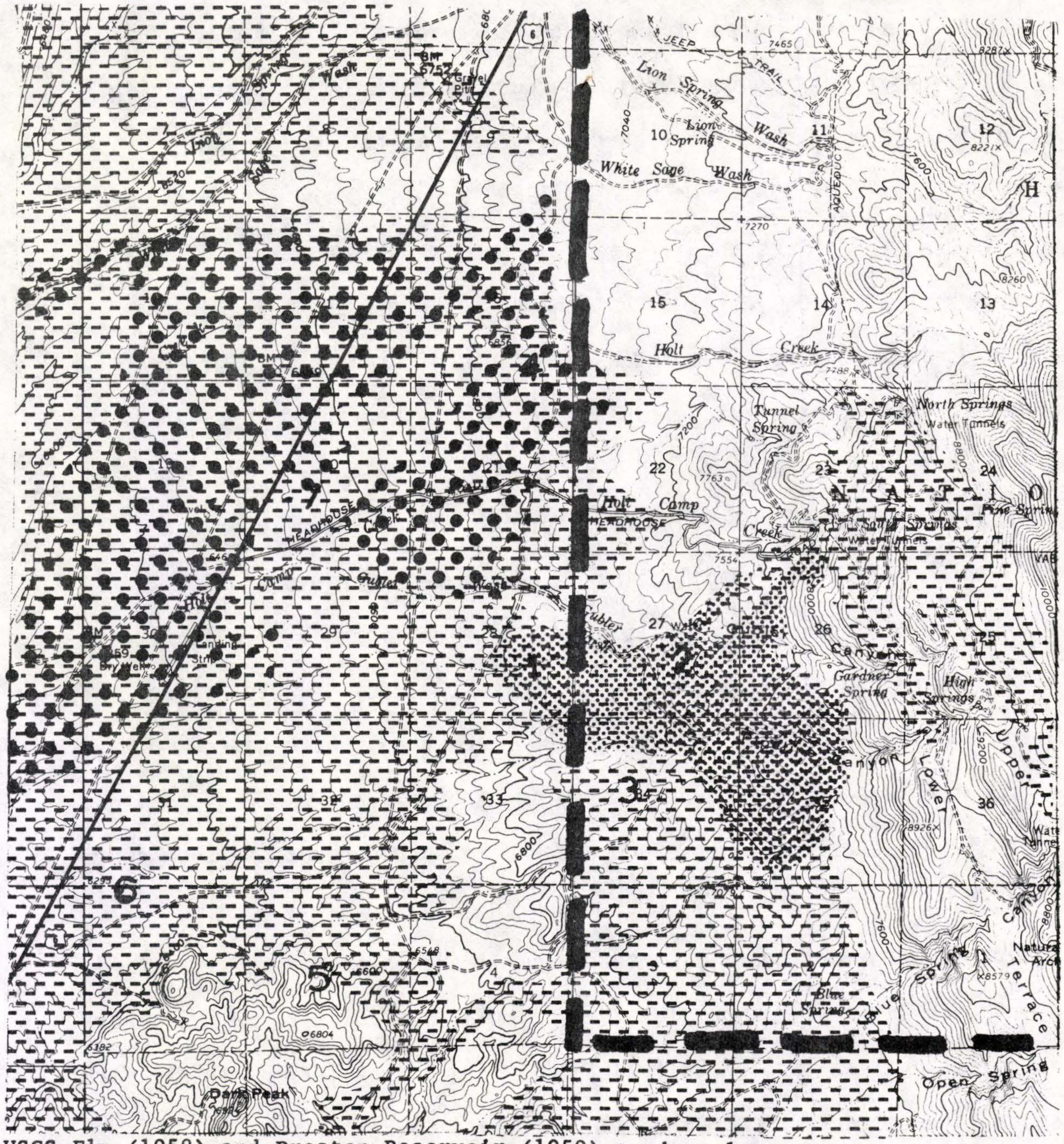
Julander et al. (1963) stated that the pellet group count method can be used to estimate the relative intensity of use of an area. In order to compare use on different areas or types, the data is converted to pellet groups per unit area.

Cole (1968) used pellet counts to determine the degree of deer use and areas of concentration on rehabilitated Nevada ranges in pinyon-juniper. Pellet group counts have been used to show that significantly more winter use by deer occurs on south facing slopes than on west or north facing slopes (Loveless 1963). Counts have also shown that deer used a burned area more than an unburned area of pinyon-juniper during the fall and winter in Arizona (McCulloch 1969). A study in Colorado used pellet group counts to show deer use in relation to distance from cover (Minnich 1969).

The plots used for counts are usually small and located in a stratified random method. The most common plots are circular and .01 acre or 100 square feet in size (Loveless 1963; McCulloch 1969). Small plots are desirable for both speed and accuracy of counts (Julander et al. 1963).

LOCATION

Three ages of wildfires (Fig.10) were sampled during the 1975 field season on the west slopes of Ward Mountain (T15N;R62E and T14N; R62E) in the Egan Range of eastern Nevada (Fig. 11). The soils of this area are of lime-


Lion Spring Wash
Lion Spring
White Sage Wash
JEEP TRAIL
AQUEDUCT
Holt Creek
Tunnel Spring
North Springs
Water Tunnels
N A T I O
Pine Spring
Holt Camp Creek
HEADHOUSE
Gubler Canyon
Gardner Spring
High Springs
Lower
Upper
Blue Spring
Open Spring
Terrace Canyon
Natural Arch
Dark Peak
1
2
3
4
5
6
7

USGS Ely (1958) and Preston Reservoir (1959) quadrangles

▬ ▬ Forest Service Boundary

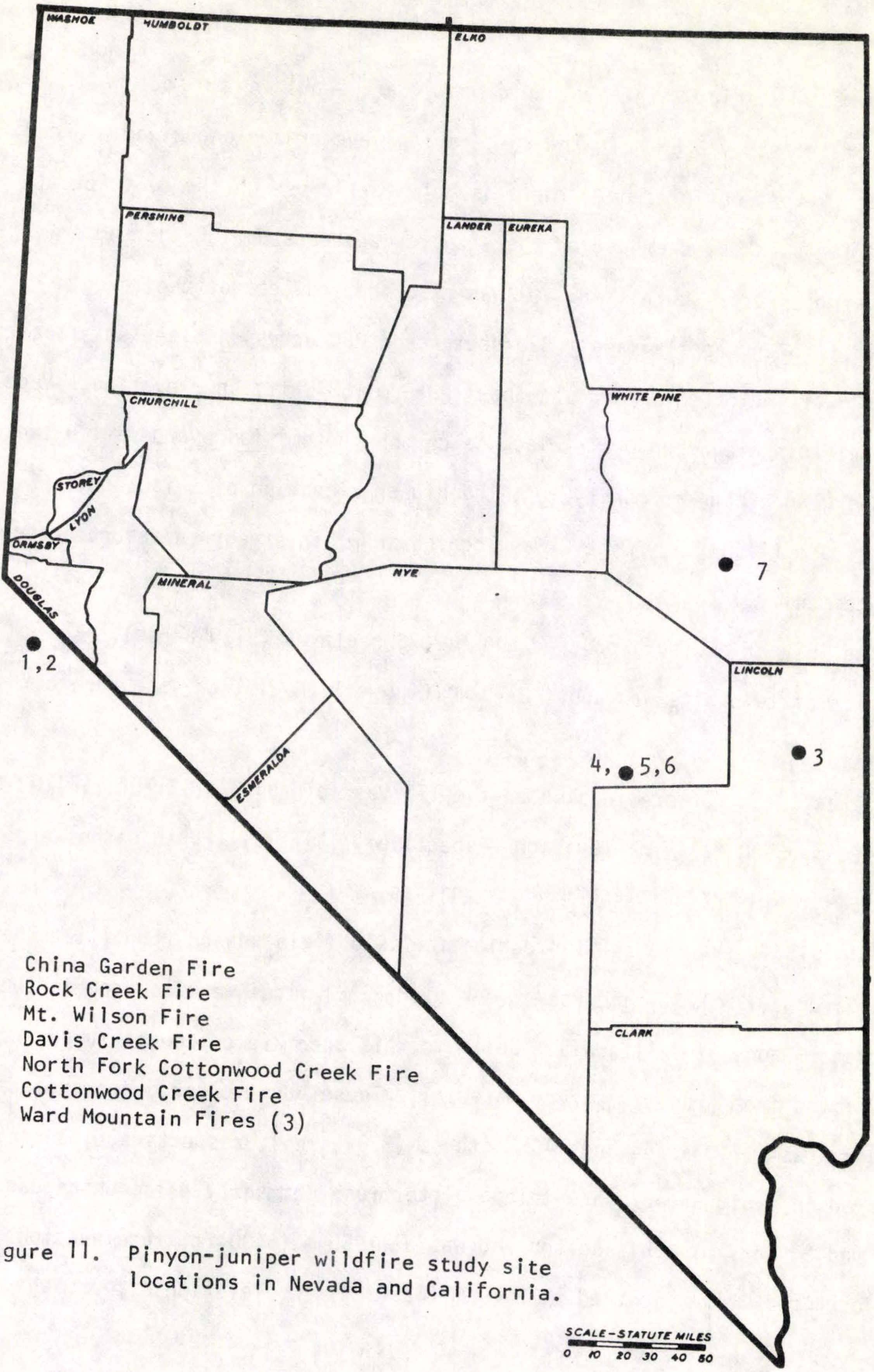
Figure 10. Fire history of pinyon-juniper vegetation on Ward Mountain White Pine County, Nevada.

░ 24 year old burn

▤ 115 year old burn

● 45 year old burn

1 Numbers indicate study sites


WASHOE
HUMBOLDT
ELKO
PERSHING
LANDER
EUREKA
WHITE PINE
CHURCHILL
STOREY
LYON
ORMSBY
DOUGLAS
MINERAL
NYE
7
1,2
LINCOLN
ESMERALDA
3
4, 5,6
CLARK
SCALE-STATUTE MILES
0 10 20 30 40 50

1 China Garden Fire
2 Rock Creek Fire
3 Mt. Wilson Fire
4 Davis Creek Fire
5 North Fork Cottonwood Creek Fire
6 Cottonwood Creek Fire
7 Ward Mountain Fires (3)

Figure 11. Pinyon-juniper wildfire study site locations in Nevada and California.

stone parent material with a volcanic peak (Dark Peak) in the southwest corner of the study area. In the past, sheep have grazed on Bureau of Land Management areas but presently there is only cattle use on the U.S. Forest Service lands. Most deer use on the study area occurs during the summer.

The most recent burn (Fig. 10) was also the smallest of the three sampled, covering approximately 520 hectares (1280 acres). Site 1 was located at the lower end of this burn, at about 2085 m (6840 ft) in elevation. Vegetation at this elevation was a black sagebrush (Artemisia nova/desert bitterbrush (Purshia glandulosa) community. At the higher elevation of this burn, about 2180 m (7150 ft). Site 2 was located in a big sagebrush/desert bitterbrush community.

The 45 year old burn covered about 2075 hectares (5130 acres). The elevation at this site was about 2110 m (6920 ft) in a black sagebrush community.

Sites 3, and 5 were located on the 115 year old burn at 2170 m (7120 ft) and 1985 m (6520 ft), in elevation respectively (Fig.10). Both sites were in big sagebrush/desert bitterbrush communities.

Six wildfires were sampled during the 1976 field season (Fig.11). The China Garden (T7N;R23E) and Rock Creek (T8N;R23E) fires were located in the Sweetwater Range of California. Soils in this area are coarse textured and are derived from granitic parent material. These burns covered approxumately 690 hectares (1710 acres) and 146 hectares (360 acres), respectively, and occurred in a big sagebrush/antelope bitterbrush community. The China Garden fire was 2 years old this season and was at 1950 m (6400 ft) in elevation. The rock Creek fire occurred at 2070 m (6800 ft) in elevation 3 years ago.

These two burns are completely protected from livestock grazing and are in an important mule deer wintering area.

The Mt. Wilson fire (T4N;R68E) was in the Wilson Creek Range of eastern Nevada. Soils in this area are derived from rhyolites and limestone parent material. The area burned 2 years ago in a big sagebrush/antelope bitterbrush community. The burn covered 4170 hectares (10,300 acres) at 2285 m (7500 ft) in elevation. The burned area has been fenced and protected from livestock grazing since the fire, however cattle use may be permitted by the BLM within the next year or so. Most deer use on the burn occurs during the summer but the lower slopes receive spring and fall use.

The Davis Creek (T2N:R55E), Cottonwood Creek (T3N;R56E), and North Fork Cottonwood Creek (T2N; R56E) fires were in the Quinn Canyon Range of the Humboldt National Forest in eastern Nevada. Soils are derived from limestone and extrusive igneous parent materials. The Davis Creek site was a 4 year old burn that covered approximately 80 hectares (200 acres). The elevation at this site was 2440 m (8000 ft) in a curlleaf mountain mahogany community. The Cottonwood Creek fire burned 140 hectares (350 acres) 16 years ago in a curlleaf mountain mahogany/big sagebrush community at 2375 m (8000ft) in elevation. The previous year, at 1980 m (6500 ft) elevation, the Cottonwood Creek fire burned 15 hectares (35 acres) in a big sagebrush/black sagebrush community. All the areas receive yearly cattle use and were not protected for any period of time after burning. The first two burns receive summer deer use, while the last is mainly spring-fall and open winter range.

METHODS

Pinyon-juniper wildfires were located using aerial photos, by contact with U.S. Forest Service personnel in Nevada and California, and with BLM and

Nevada Fish and Game personnel in Nevada. Pinyon wedges were collected at Ward Mountain sites from fire scarred trees for aging burns by ring counts. Wedges from the 24 year old burn were collected as a check on aging methods, since the burn age was already known.

Vegetation was sampled both inside and outside the burns. Variables measured include: canopy cover of trees and shrubs, and basal area cover of grasses and forbs. Sampling was done with the 0.1 hectare macroplot described in the section on vegetation response to burning. Each macroplot was described by noting: slope, aspect, elevation and age of burn.

Pellet group and track sampling was used to compare deer use of various areas and sizes of burns. It was assumed that dark pellet groups represent use occurring in the recent past (Beall per. comm.). So, only unbleached groups were tallied to sample recent deer activity. Track counts were used to represent use by deer that occurred during or just before the time of sampling.

Sampling was done using a 20 by 0.5 meter belt transect laid parallel to the burn edge. Plots were run to attain results within 10% of the mean for distances of 0-50, 50-100, 100-200, 200-300, 300-400, and 400-600 meters from the burn edge (Fig. 12). Sampling was done both inside and outside the burn. Slope, aspect, and elevation were recorded with each plot during the 1976 field season.

Analysis of variance was used to determine significant differences in vegetation on burned and unburned areas, and on burns of different ages. Multiple regressions were used to show evegetation changes of burned areas with increasing burn ages.

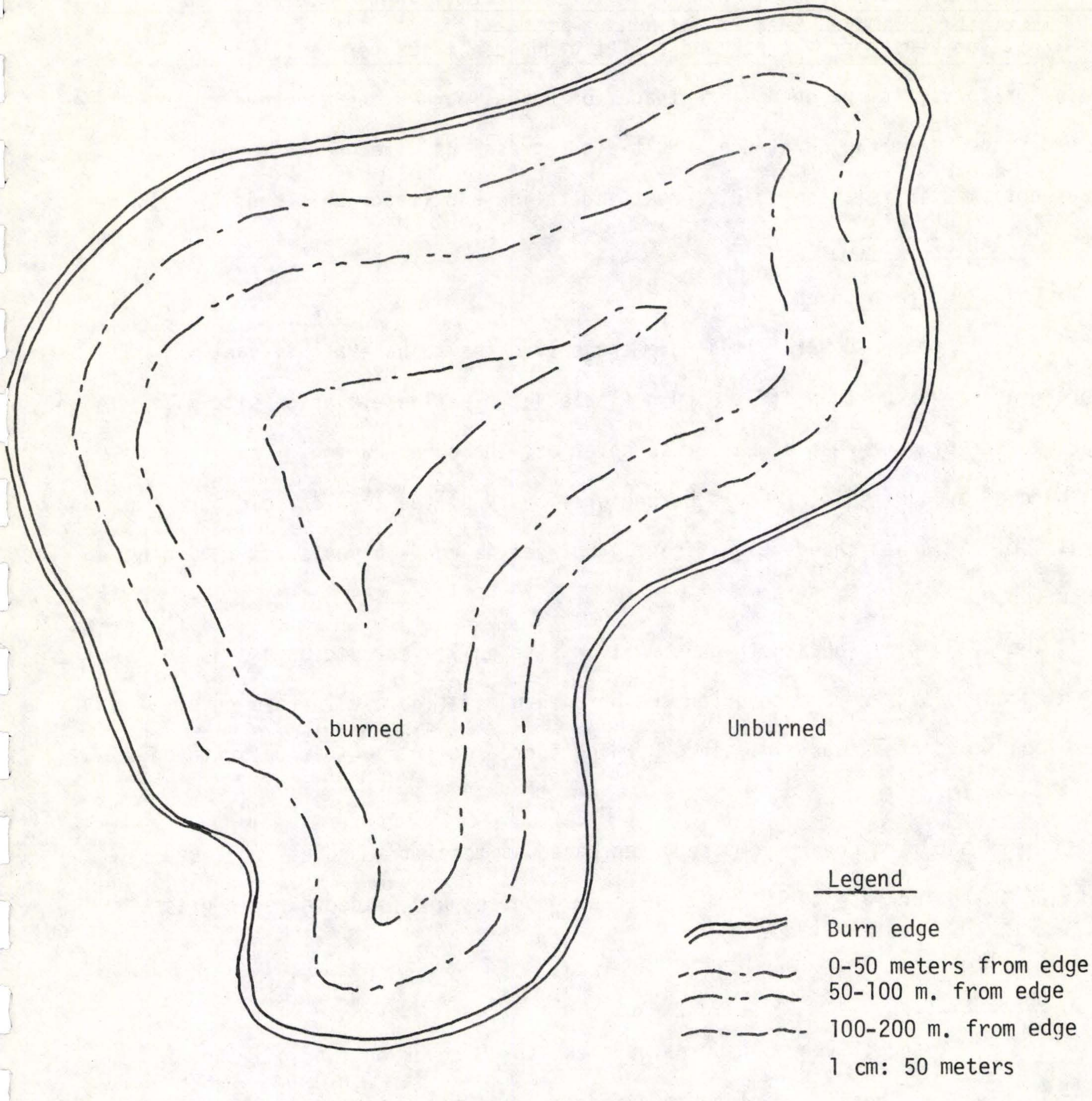

burned
Unburned
Legend
Burn edge
0-50 meters from edge
50-100 m. from edge
100-200 m. from edge
1 cm: 50 meters

Figure 12. A stratification design for mule deer track and pellet group sampling using 20 X .5 meter transects on wildfire burns in the pinyon-juniper type.

Analysis of variance was also used to show significant differences in deer use (as measured by track and pellet group densities per hectare) in relation to vegetation on different ages of burns, burned and unburned areas, and distance from the burn edge. Multiple regressions were used to show deer activity in relation to different vegetation and topographic conditions.

RESULTS AND DISCUSSION

Grass and Forb Cover

The 115 year old burn sites were the only sites to have significantly more grass cover on than off the burn (Table21). The low elevation site of the 24 year old burn had higher grass cover off the burn than on. The "unburned" area of this site was burned previously by the 115 year old burn. Grass cover did not change significantly between 45 and 115 years after burning occurred.

The 2, 3, 4, 16 and 24 (high elevation site only) year old burns had significantly higher forb cover on the burn than off (Table 22). Forb cover was found to decrease as time since burning increased (r^2=.64) at the rate of 0.1% every 10 years.

Grass and forb cover (combined) decreased as total tree cover increased (r^2=.56). An increase of 10% in tree cover produced a 0.6% decrease in grass and forb cover.

Shrub Cover

The 2, 3, and 17 year old burns had less shrub cover on than off the burn (Table 23). The 4 year old burn difference was insignificant. All other burned areas had higher shrub cover values than the unburned areas.

The 2 and 3 year old burns are in a grass-forb stage of succession with little or no shrub cover established. After this stage the literature

Table 21. Percent basal area cover of grass species on burned and unburned areas of eleven study sites in Nevada and California.

		2 Yr. Old Burns				3 Yr. Old Burn		4 Yr. Old Burn		16 Yr. Old Burn		17 Yr. Old Burn	
Tribe	Species	Mt. Wilson		China Garden[1]		Rock Creek[1]		Davis Creek[2]		Cottonwood Ck.[2]		N. Fk. Cottonwood[2]	
		B[3]	U[4]	B	U	B	U	B	U	B	U	B	U
Poeae	Bromus inermis	.34											
	Bromus tectorum			.35	.30	.48	.30		.09		T**	.15	.09
	Poa fendlerana												
	Poa sandbergii	.12	.45	T	.09		.09					T	T
Stipeae	Oryzopsis hymenoides					T							
	Stipa comata												
	Stipa thurberiana					T							
Triticeae	Agropyron cristatum	.55		T		.34							
	Agropyron intermedium	.35		.34		T							
	Agropyron spicatum		.73									T	T
	Elymus cinereus												
	Sitanion hystrix	.23	.93	T								T	.13
Zoysieae	Hilaria jamesii											T	T
	Total grass Cover	1.49	2.11	.84	.39	.92	.39	0	.09	0	T	.35	.42

		24 Yr. Old Burns				45 Yr. Old Burns		115 Yr. Old Burns			
		2085 m[5]		2180 m.		2110 m.		1985 m.		2170 m.	
		B *	U	B	U	B	U*	B	U	B	U
Poeae	Bromus inermus										
	Bromus tectorum	.06	T	T	T	T	T	T		.24	T
	Poa fendleriana										
	Poa sandbergii	.16	.12	.63	T	.17	.28	.36	T	.07	T
Stipeae	Oryzopsis hymenoidies	.25	T	.41	.6	.13	T			.12	.6
	Stipa comata	T		T		T		T			
	Stipa thurberiana							.89			
Triticeae	Agropyron cristatum		T								
	Agropyron intermedium										
	Agropyron spicatum	1.78	3.25	.17	t	3.42	3.70	.73	T	1.94	T
	Elymus cinereus										
	Sitanion hystrix	.10	.12	T	T	.15		.16	T	T	T
Zoysieae	Hilaria jamesii										
	Total grass cover	2.40	3.64	1.36	.8	3.97	4.08	2.24	.15	2.42	.8

---

[1] California Sites

[2] Quinn Canyon Sites

[3] Burned

[4] Unburned

[5] Elevation in meters

* Part of 115 year old burn

** Trace

Table 22. Percent basal area cover of forb species on burned and unburned areas of 11 study sites in Nevada and California.

		2 Yr. Old Burns				3 Yr. Old Burn		4 Yr. Old Burn		16 Yr. Old Burn		17 Yr. Old Burn	
		Mt. Wilson		China Garden[1]		Rock Creek[1]		Davis Creek[2]		Cottonwood Ck.[2]		N. Fk. Cottonwood[2]	
Family	Species	B[3]	U[4]	B	U	B	U	B	U	B	U	B	U
Amaryllidaceae	Allium nevadense (P)*										T		
Apiaceae	Cymopterus watsonii (P)												
Asteraceae	Agoseris glauca (P)									T			
	Balsamthoriza sagittata (P)									.24	T		
	Crepis acuminata (P)												
	Crepis occidentalis (P)			T								T	T
	Erigeron divergens (B)												
	Erigeron eatonii (P)												
	Erigeron pumilus (P)												
	Erigeron sp. (P)	.13	T			.14							T
	Eriophyllum wallacei (A)												
	Haplopappus acaulis (P)												
	Iva axillaris (P)												
	Lactuca tatarica (P)			.07		.19							
	Lygodesmia spinosa (P)	T				T						T	T
	Senecio multilobatus (P)												T
Boraginaceae	Cryptantha circumscissa (A)			.21		T							
	Cryptantha echenoides (A)												
	Cryptantha gracilis (A)			1.84		.26							
	Cryptantha jamesii (A)	.14											.06
	Lappula redowskii (A)												
Brassicaceae	Arabis holbolli var. retrofacata (P)												
	Caulanthus crassicaulis (P)								T				
	Descurainia californica (B)			T		.28							
	Descurainia richardsonii (B)												
	Lepidium perfoliatum (A)											T	
	Physaria didymocarpa (P)												
	Sisymbrium altissimum (A)					T							
	Streptanthus cordatus (P)												
Cactaceae	Opuntia sp. (P)												
Caryophyllaceae	Arenaria kingii (P)											T	
Chenopodiaceae	Chenopodium album (A)	T		T		T							
	Salsola kali (A)	T				1.03							
Euphorbiaceae	Euphorbia albomarginata (P)											.52	
	Euphorbia sp. (A)												
Fabaceae	Astragalus lentiginosus (P)												
	Astragalus minthorniae (P)												T
	Astragalus purshii (P)	T										T	T
	Astragalus sp. #1 (A)	T										T	
	Astragalus sp. #2 (A)												
	Lupinus arbenteus (P)								T	1.41	.15	.15	T
	Lupinus sp. (P)												
	Melilotus alba (A)			.25									
	Melilotus officinalis (A)	.67											
	Petalostemon ornatus (P)												
Gentianaceae	Frasera albormarbinata (P)												
Liliaceae	Caldchortus nuttallii (P)												
	Frittillaria atropurpurea (P)												
	Zigadenous paniculatus (P)											T	
Loasaceae	Mentzelia laevicaulis (B)						.09						
Mal aceae	Sphaeralcea ambigua (P)	.48	T									T	
Onagraceae	Gayophytum ramosissimum (A)	T		T									
Papaveraceae	Argemone munta sp. rotundata (P)					.2		.11					
Polemoniacr.e	Gilia interior (P)	T										T	T
	Gilia leptomeria (P)			.33	T	T	T						
	Microsteris gracilis (A)					T			T				
	Phlox diffusa (P)												
	Phlox stansburyi (P)	.49	T						T	.08		.07	T
Polygonaceae	Eriogonum caespitosum (P)											T	T
	Eriogonum ovalifolium (P)	T											
	Eriogonum umbellatum (P)												T
	Eriogonum sp. (P)	T		T		.77		.02					
	Polygonum sp. (A)												
Ranunculaceae	Delphinium andersonii (P)												
Rubiaceae	Galium bifolium (A)								T				
Santalaceae	Comandra pallida (P)												
Scrophulariaceae	Castilleja chromosa (P)											T	T
	Penstemon eatonii (P)												
	Penstemon humilis (P)										.06		
	Penstemon miser (P)												
	Penstemon palmeri (P)							1.24					
	Penstemon sp. (P)	T										T	
Solanaceae	Nicotiana attenuata (A)	T						.62					
Total Annual Cover		1.06	0	2.45	0	1.77	0	.71	.1	0	0	.15	.06
Total Perennial Cover		1.40	.15	.5	T	1.40	T	1.37	.15	1.78	.31	1.24	.6
Total Forb Cover		2.46	.15	2.95	T	3.17	T	2.08	.25	1.78	.31	1.39	.66

[1] California Sites
[2] Quinn Canyon Sites
[3] Burned
[4] Unburned
[5] Elevation in Meters
**. Part of 115 year old burn
*(P) = Perennial
(A) = Annual
(B) = Biennial

Table 22. (Cont'd)

		24 Yr. Old Burn				45 Yr. Old Burns		115 Yr. Old Burns			
		2085 m.[5/]		2180 m.		2110 m.		1985 m.		2170 m.	
		B[2/]	U[3/]**	B	U	B	U**	B	U	B	U
Amaryllidaceae	Allium nevadense (P)*	T	T			T					
Apiaceae	Cymopterus watsonii (P)							T	T		
Asteraceae	Agoseris glauca (P)			T							
	Balsamthoriza sagittata (P)										
	Crepis acuminata (P)	.06	T	T	T			T		.08	T
	Crepis occidentalis (P)										
	Erigeron divergens (B)					T					
	Erigeron eatonii (P)	T	.08			.07	T				
	Erigeron pumilus (P)										
	Erigeron sp. (P)			T							
	Eriophyllum wallacei (A)										
	Haplopappus acaulis (P)				T		T	T			T
	Iva axillaris (P)										
	Lactuca tatarica (P)										
	Lygodesmia spinosa (P)			T		T		T		T	
	Senecio multilobatus (P)			T							
Boraginaceae	Cryptantha circumscissa (A)										
	Cryptantha echenoides (A)										
	Cryptantha gracilis (A)		T								
	Cryptantha jamesii (A)	.13	T	T	T	.13	.17	T	.08	.24	T
	Lappula redowskii (A)	T	T	T				T	T	T	
Brassicaceae	Arabis holbolli var. retrofacata (P)			T					T		
	Caulanthus crassicaulis (P)						T				T
	Descurainia californica (B)										
	Descurainia richardsonii (B)				T			T	T	T	T
	Lepidium perfoliatum (A)										
	Physaria didymocarpa (P)								T		
	Sisymbrium altissimum (A)										
	Streptanthus cordatus (P)		T			T	T		T		
Cactaceae	Opuntia sp. (P)		T					T			
Caryophyllaceae	Arenaria kingii (P)		.08	T	T	.51	.06	T	T	.10	T
Chenopodiaceae	Chenopodium album (A)										
	Salsola kali (A)										
Euphorbiaceae	Euphorbia albomarginata (P)										
	Euphorbia sp. (A)										
Fabaceae	Astragalus lentiginosus (P)	T	.08	T		T					
	Astragalus minthorniae (P)										
	Astragalus purshii (P)	T		T				T	T		
	Astragalus sp. #1 (A)	T			T				T		
	Astragalus sp. #2 (A)		T	T	T	T	T			T	T
	Lupinus arbenteus (P)										
	Lupinus sp. (P)			T							
	Melilotus alba (A)										
	Melilotus officinalis (A)										
	Petalostemon ornatus (P)							T			
Gentianaceae	Frasera albormarbinata (P)			T	T				T		T
Liliaceae	Caldchortus nuttallii (P)			T		T	T	T		T	
	Frittillaria atropurpurea (P)										
	Zigadenous paniculatus (P)										
Loasaceae	Mentzelia laevicaulis (B)										
Maluaceae	Sphaeralcea ambigua (P)	T						T			
Onagracr:e	Gayophytum ramosissimum (A)							T			
Papaveraceae	Argemone munta sp. rotundata (P)										
Polemoniaceae	Gilia interior (P)	T	T	T	T	.06	T	T	T	T	T
	Gilia leptomeria (P)										
	Microsteris gracilis (A)							T	T	T	
	Phlox diffusa (P)	.69	.77	2.79	.32	.74	.33	.19	.12	.46	.32
	Phlox stansburyi (P)	.10	.06	T	T	T	T	.06	T	.06	T
Polygonaceae	Eriogonum caespitosum (P)		.15					.14	T		
	Eriogonum ovalifolium (P)		T	T		T	T	T	T		
	Eriogonum umbellatum (P)										
	Eriogonum sp. (P)										
	Polygonum sp. (A)										
Ranunculaceae	Elphinium andersonii (P)	T	T	T		T	T	T			
Rubiaceae	Galium bifolium (A)										
Santalaceae	Comandra pallida (P)	T	T	T			T			T	
Scrophulariaceae	Castilleja chromosa (P)	T	T	T		T					
	Penstemon eatonii (P)										
	Penstemon humilis (P)								T		
	Penstemon miser (P)	T	T	T		T					
	Penstemon palmeri (P)									T	
	Penstemon sp. (P)	.08	T	T	T	T	T				
Solanaceae	Nicotiana attenuata (A)										T
Total Annual Cover		.18	.25	.1	.15	.23	.27	.25	.28	.39	.15
Total Perennial Cover		1.43	1.77	3.84	.72	1.93	.89	1.04	.72	1.0	.72
Total Forb Cover		1.61	2.02	3.94	.87	2.16	1.16	1.29	1.00	1.39	.87

Table 23. Percent shrub cover by species on burned and unburned areas of eleven study sites in Nevada and California.

	2 Yr. Old Burns				3 Yr. Old Burn		4 Yr. Old Burn		16 Yr. Old Burn		17 Yr. Old Burn	
	Mt. Wilson		China Garden[1]		Rock Creek[1]		Davis Creek[2]		Cottonwood Ck.[2]		N. Fk. Cottonwood[2]	
	B[3]	U[4]	B	U	B	U	B	U	B	U	B	U
Artemisia tridentata	1	12	0	1	0	1	0	0	37	4	12	9
Artemisia nova	0	0	0	0	0	0	0	0	0	0	1	11
Purshia glandulosa	0	0	0	0	0	0	0	0	0	0	0	0
Purshia tridentata	0	5	0	6	0	6	0	0	0	0	2	3
Chrysothamnus viscidiflorus	0	3	0	0	0	0	0	0	0	0	2	1
Symphoricarpus alba	0	0	0	0	0	0	0	0	0	7	0	0
Ephedra viridis	0	0	0	0	0	0	0	0	0	0	0	1
Ribes inerme	0	0	0	0	1	0	0	0	0	0	0	0
Cercocarpus ledifolius	0	0	0	0	0	0	0	5	0	9	0	0
Other	1	0	1	1	0	1	1	1	5	1	0	0
Total	2	20	1	8	1	8	1	6	42	21	17	25

	24 Yr. Old Burns				45 Yr. Old Burn		115 Yr. Old Burn			
	2085 m[5]		2180 M.		2110 m.		1985 m.		2170 m.	
	B	U *	B	U	B	U*	B	U	B	U
Artemesia tridentata	0	0	16	1	0	0	6	0	7	1
Artemisia nova	27	24	2	0	21	14	9	1	8	0
Purshia glandulosa	6	2	8	3	3	5	4	2	8	3
Purshia tridentata	0	0	0	0	0	0	0	0	0	0
Chrysothamnus viscidiflorus	5	2	8	0	3	0	2	0	5	0
Symphoricarpus alba	0	0	0	0	0	0	0	0	2	0
Ephedra viridis	0	0	0	2	0	0	0	0	0	2
Ribes inerme	0	0	1	0	0	0	0	0	1	0
Cercocarpus ledifolius	0	0	0	2	0	0	0	0	0	2
Other	0	0	0	0	0	0	0	0	0	0
Total	38	28	35	8	27	19	22	3	31	8

[1] California Sites

[2] Quinn Canyon Sites

[3] Burned

[4] Unburned

[5] Elevation in meters

* Part of 115 year old burn

indicates shrubs will usually become dominant (Arnold et al. 1964; Barney and Frischknect 1974). All the burns 16 through 115 years old were in a shrub dominated stage of succession.

The "unburned" part of the North Fork Cottonwood Creek site appeared to have been burned at sometime before the fire 17 years ago and is still in a shrub dominated stage of succession. This is probably why shrub cover on the 17 year old burn was not significantly greater than on the unburned part.

Shrub cover decreased significantly between 24 and 115 years and between 45 and 115 years after burning at the 2085 and 2110 m elevations, respectively.

Tree Cover

Tree cover was broken down into pinyon, juniper, and total tree cover (Table 24). All sites, except the Cottonwood Creek and the 45 year old Ward Mountain burn, had significantly lower pinyon and total tree cover on than off the burns.

As was mentioned above, the Cottonwood Creek site's "unburned" area appeared to be in a shrub dominated stage of succession. This is probably why pinyon, juniper, and total tree cover on this site were not significantly different on and off the 17 year old burn.

Pinyon cover on the 45 year old burn was not significantly different from the amount of cover on the 115 year old burn at the 2110 m (6920 ft) elevation. At this elevation, pinyon cover did not increase significantly between 45 and 115 years after the area was burned.

All ages of burns on Ward Mountain had lower amounts of juniper cover than the unburned areas. Very little juniper occurred on the other study sites.

A positive correlation (r^2=.76) was found to exist between time since burning and total tree cover. After a burn is about 25 years old, total tree cover increased 0.18% each year. See Appendix O for detailed vegetation data.

Table 24 Percent pinyon, juniper and total tree cover on burned and unburned areas of eleven study sites in Nevada and California.

Species	2 Yr. Old Burns				3 Yr. Old Burn		4 Yr. Old Burn		16 Yr. Old Burn		17 Yr. Old Burn	
	Mt. Wilson		China Garden 1/		Rock Creek 1/		Davis Creek 2/		Cottonwood Ck. 2/		N. Fk. Cottonwood 2/	
	B 3/	U 4/	B	U	B	U	B	U	B	U	B	U
Pinus monophylla	0	12.3	0	44.6	0	44.6	0	53.6	0	36.6	0	1.17
Juniperus osteosperma	0	1.4	0	0	0	0	0	0	0	0	0	2.7
Total Tree Cover	0	13.7	0	44.6	0	44.6	0	53.6	0	36.6	0	4.4

	24 Yr. Old Burns				45 Yr. Old Burns		115 Yr. Old Burns			
	2085 m 5/		2180 m.		2110 m.		1985 m.		2170 m.	
	B	U *	B	U	B	U*	B	U	B	U
Pinus monophylla	0	0	0	21.0	.3	1.3	1.5	19.3	3.0	21.0
Juniperus osteosperma	.1	5.0	0	17.3	.3	8.3	3.8	14.4	2.6	17.3
Total Tree Cover	.1	5.0	0	38.4	.6	9.6	5.3	33.7	5.5*	38.4

1/ California Sites

2/ Quinn Canyon Sites

3/ Burned

4/ Unburned

5/ Elevation in Meters

* Part of 115 year old burn

Ground Cover

Ground cover was broken down into five types: vegetation, litter, bare ground, rock, and pavement (Table 25). The sites having significantly higher amounts of vegetative ground cover on the burn than off were the 2 and 3 year old California burns and the 24 year old Ward Mountain burn.

The only sites that did not have significantly less litter cover on the burn than off were the 16 and 45 year old burns and the 2085 m elevation site of the 24 year old burn. The differences on these sites were insignificant. Litter cover was positively correlated (r^2=.77) with pinyon cover. Litter cover increased slightly less than 1% with each increase of 1% in pinyon cover.

The percent of bare ground cover was higher on than off the 2 and 3 year odl California burns and the 4 and 115 year old Nevada burns. All other sites had essentially equal amounts of bare ground on and off the burn.

Pavement cover was higher on than off the 2 year old burn at Mt. Wilson. The 1985 m elevation site of the 115 year old burn had lower pavement cover on than off the burned area. All other sites had equal amounts of pavement ground cover between areas. Pavement cover was negatively correlated (r^2=.57) with percent slope.

Mule Deer Use

Pellet group densities were greater on the burned than unburned areas of the high elevation sites on the 24 and 115 year old burns (Table26). Densities were greater on the unburned than the burned areas of the 2 and 3 year old California burns and the 4 year old Davis Creek burn. All other sites had insignificant differences on and off burned areas. A flash flood on the Quinn Canyon burns destroyed much of the evidence of deer use.

On the California burns, winter range use by deer (as measured by pellet group densities) was found to be positively correlated (r^2=.88) with

Table 25. Vegetation, ground cover, and mule deer use on burned and unburned areas of eleven study sites in Nevada and California.

		2 Yr. Old Burns				3 Yr. Old Burn		4 Yr. Old Burn		16 Yr. Old Burn		17 Yr. Old Burn	
Cover Type		Mt. Wilson		China Garden[1]		Rock Creek[1]		Davis Creek[2]		Cottonwood Ck.[2]		N. Fk. Cottonwood[2]	
		B[5]	U[6]	B	U	B	U	B	U	B	U	B	U
Vegetation Cover (%)													
Grass	Basal Area Cover	1	2	1	T	1	T	0	T	0	T	T	T
Forb		1	T	3	T	3	T	2	T	2	T	1	T
Shrub		2	20	1	8	1	8	1	6	42	21	17	25
Pinyon		0	12	0	45	0	45	0	65	0	37	0	2
Juniper		0	1	0	0	0	0	0	0	0	0	0	3
Total Tree		0	14	0	45	0	45	0	54	0	37	0	4
Ground Cover (%)													
Vegetation		4	3	8	0	7	0	3	1	1	0	3	1
Litter		8	50	15	78	24	78	4	74	59	65	29	43
Bare		16	13	77	13	69	13	82	10	8	5	17	18
Rock		1	0	1	2	1	2	7	5	0	2	11	5
Pavement		71	34	T	7	0	7	3	10	32	29	39	33
Mule Deer Use													
Pellet Groups	Per Hectare	410	452	2893	6016	4588	5778	67	320	129	173	380	274
Tracks		1084	957	260	1159	53	182	283	389	581	173	0	0

		24 Yr. Old Burns[3]				45 Yr. Old Burns[3]		115 Yr. Old Burns[3]			
Cover Type		2085 m.[4]		2180 m.		2110 m.		2170 m.		1985 m.	
		B	U*	B	U	B	U*	B	U	B	U
Vegetation Cover (%)											
Grass	Basal Area Cover	2	4	1	T	4	4	3	T	2	T
Forb		1	2	4	1	2	1	1	1	1	1
Shrub		38	28	35	8	27	19	31	8	22	3
Pinyon		0	0	0	21	T	1	3	21	2	19
Juniper		T	5	0	17	T	8	3	17	4	14
Total Tree		T	5	0	38	1	10	6	38	5	34
Ground Cover (%)											
Vegetation		13	6	9	1	2	3	3	1	3	1
Litter		23	26	39	53	29	35	41	53	32	42
Bare		15	20	20	19	22	25	29	19	54	14
Rock		1	0	T	3	T	T	1	3	11	12
Pavement		49	48	32	24	47	37	27	24	0	31
Mule Deer Use											
Pellet Groups	Per Hectare	467	480	1396	719	60	20	894	333	550	547
Tracks		808	1319	1198	1192	0	0	2524	740	105	255

[1] California Sites

[2] Quinn Canyon Sites

[3] Ward Canyon Sites

[4] Elevation in Meters

[5] Burned

[6] Unburned

* Part of 115 Year Old Burn

Table 26 Pellet group densities per hectare at six distances from the burn edge on burned and unburned areas of five sites in Nevada and California.

Distance from Edge (Meters)	Golden Gate		Mt. Wilson		24 Yr. Old Burn				115 Yr. Old Burn	
					6840 ft[1]		7150 ft		7120 ft	
	B[2]	U[3]	B	U	B	U	B	U	B	U
0-50	3142	15416	200	917	192	475	831	394	435	137
50-100	2106	9360	435	658	678	209	1365	864	730	33
100-200	2672	9160	562	400	516	676	2171	444	1548	-
200-300	4295	957	428	419	440	745	1455	802	946	-
300-400	2422	924	458	173	449	332	836	964	888	-
400-600	-	-	388	209	547	475	1870	890	350	-

[1] Elevation

[2] Burned

[3] Unburned

litter cover. This significance was probably related to the amount of tree and shrub cover available to the animals for shelter during the winter.

Generally, factors important in attracting deer to the Ward Mountain burns were found to be big sagebrush cover and density, percent slope, forb cover, and litter cover. Combined, these factors explained 90% (r^2=.90) of the variation in pellet group densities. The sites with high pellet densities had combinations of the factors mentioned.

The factors which may be attracting mule deer use on these Ward Mountain sites supply either food or cover. Big sagebrush, in terms of canopy cover and density, supplies both cover and food needs for mule deer. Topography can supply cover as shown by the correlation between percent slope and pellet group densities. Forbs are the preferred food of mule deer, particularly during spring and early summer. Litter probably is significant in that it relates to the degree of vegetation in the area providing both cover and food.

Track densities were greater on the unburned areas of the California burns and of the low elevation sites of the 24 and 115 year old burns. Track densities were greater on the burn at the Cottonwood Creek site and the 2170 m (7120 ft) elevation site of the 115 year old Ward Mountain burn. The other five sites had no significant difference in track counts on and off the burns. Late summer use (as measured by track densities) was positively correlated (r^2=.41) with bitterbrush density.

Five sites were large enough and contained adequate pellet groups to analyze for pellet distribution relative to distance from the burn edge. The 2 year old burns were also analyzed for pellet group distribution relative to topography as measured by slope, aspect and elevation. Data is missing for the unburned area of one site due to the small amount of unburned area left by the fire (Fig. 10).

The highest concentration of use on the 2 year old burns was found within 50 meters of the edge of the unburned areas (Table 26). This concentration of use may reflect the higher use of cover near open areas. Once animals do move out into the burn, use was not related to distance from the burn edge.

Deer use on the 24 and 115 year old burns was significantly higher at some distance into the burn than along the edge of either the burned or unburned areas. These burn areas contained big sagebrush which provided cover away from the edge of the pinyon-juniper.

Topography was an important factor affecting use out on all ages of burns. Pellet group densities were positively correlated (r^2=.60) with percent slope. Steep topography on these five sites seems to have made vegetative cover less critical. Use on all the burns studied seems to be related to something other than distance from the burn edge.

RESPONSE OF WILDLIFE POPULATIONS TO PRESCRIBED BURNING IN PINYON-JUNIPER WOODLANDS

INTRODUCTION

The primary objective of this phase of the project was to determine the response of small mammals and birds to prescribed burning in pinyon-juniper woodlands.

Miller (1963) stated that the primary objective of wildlife management is the manipulation of food and cover to better benefit wildlife species. This is best accomplished through the maintenance of a more diversified habitat. A diversity in the habitat will mean a diversity in the wildlife species.

METHODS

Sixty-five rodent traplines were conducted during the study period. Twenty traplines were conducted the first season with each trapline run in the same location for three consecutive nights. Forty-five traplines were conducted during the second field season for two nights instead of three. Combining both field seasons some individual rodent traplines, totaling 7500 trap nights, were conducted during the study.

Sixty-five bird transects were conducted during the study. Twenty bird transects were conducted the first season and forty-five the second season. Ninety individual bird transects were conducted during the second season. Combining both field seasons 155 individual bird transects, totaling 105 hours of observation time were conducted during the study.

Of the 150 individual rodent or bird transects, 47% were conducted in burned areas, 43% in unburned areas, and 10% in ecotone areas (transition between burned and unburned areas).

RESULTS

Rodents

A summation of individual rodents caught during each census period enabled a test for normality to be performed (Table 27). A total of 1059 rodents were caught during the study, 474 the first season and 585 the second. The mean number of rodents caught per night the first season was 7.9, while the mean number caught the second season was 6.5. The fluctuation in rodent numbers was greatest for the second season (SD=8.3), with a more stable number of rodents being encountered the first season (SD=4.5). In both census periods the rodent population had a positive skewness of less than one. The rodent population the first and second seasons had slightly above normal kurtosis values (CK=3.9 and 3.5, respectively).

All differences described are significant at the .05 level of probability.

Table 28 categorizes the study area into burned, unburned, and ecotone areas, with the respective rodent numbers caught in each category. There was no significant difference between rodent numbers on burned, unburned, or ecotone areas. Rodent numbers were significantly higher the first season opposed to the second. More rodents were captured on ecotone areas than either burned or unburned areas.

No significant difference was found between the number of rodent species within seasons, between seasons, or between treatments (Table 29). Unburned areas had a consistently higher diversity of rodents.

Table 27. Results obtained from normality tests conducted on the number of animals encountered per transect study sites at the White River area Humboldt National Forest, Nevada.

	mean number per transect	total number	mode	median	standard deviation	coefficient skewness	coefficient kurtosis
Rodent Data							
Year one	7.9	474	8.0	8.0	4.5	.4	3.9
Year two	6.5	585	3.0	4.0	8.3	.4	2.3
Bird Data							
Year one	21.3	943	10.0	19.0	11.1	1.4	6.1
Year Two	19.4	1832	16.0	20.0	22.9	.8	2.8

Percent plant cover on burned areas was broken down into three categories: 0-10%, 11-24%, and greater than 24%. During both field seasons a significantly greater number of rodents were found in the greater than 24% cover category (Table 30).

No difference was found between either the number of young or female rodents caught on burned, unburned, or ecotone areas.

During the first season a positive relationship (r^2=.8) was found to exist between the number of rodents caught per trapline and percent ground cover of plants on burned areas. The second season no correlation was found (r^2=.4) to exist between the number of rodents caught per trapline and percent ground cover of plants on burned areas.

A total of sixteen mammal species representing four orders and seven families were encountered during the study (Table 1 Appendix Q). Deer mice (*Peromyscus maniculatus*) were the most abundant rodent caught throughout the study, followed by least chipmunks (*Eutamias mimimus*), pinyon mice (*Peromyscus trueii*),longtailed pocket mice (*Perognathus formosus*), and Ord's kangaroo rat (*Dipodomys ordii*). Other species trapped were done so in comparatively small numbers (Table 31).

Table 28. Mean and total number of rodents captured per trapline on burned, unburned, and ecotone areas the first and second seasons on study sites at the White River area Humboldt National Forest, Nevada.

	1974 Season		1975 Season	
	mean number	total number	mean number	total number
Burned	27.2^{a}[1]	136	12.1^{b}	341
Unburned	24.3^{a}	311	11.3^{b}	138
Ecotone	27.0^{a}	27	15.8^{b}	98
Per Season	26.2	474	13.1	585

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[1] Means with the same subscript within columns are not signigicantly different.

Table 29. The mean number of rodent species caught per trapline on burned, unburned, and ecotone areas the first and second season on study sites at the White River area Humboldt National Forest, Nevada.

	1974 Season mean number	1975 Season mean number	Mean per treatment
Burned	2.6^{a}[1]	2.4^{b}	2.5^{c}
Unburned	3.4^{a}	2.8^{b}	3.1^{c}
Edge	3.0^{a}	2.2^{b}	2.6^{c}
Per Season	3.0	2.4	

[1] Means with same subscript within columns are not significantly different.

Table 30. The mean number of rodents caught per trapline in different plant cover categories on burned areas at study sites in the White River area Humboldt National Forest, Nevada.

	1974 Season mean number caught	1975 Season mean number caught
0-10% plant cover	4.0^{a}[1]	3.5^{b}
11-24% plant cover	6.9^{a}	4.1^{b}
Greater than 24% plant cover	14.5	8.0

[1] Means with same subscript within columns are not significantly different.

Birds

A summation of individual birds encountered during the study enabled a test for distribution to be performed (Table 27). A total of 2775 birds were encountered during the study, 943 the first season and 1832 the second season. The mean number of birds encountered per transect the first season

Table 31. The total and mean number of mammals caught per trapline on burned, unburned, and ecotone areas on study sites in the White River area Humboldt National Forest, Nevada.

	1974				1975					
	Burned		Unburned		Burned		Unburned		Ecotone	
	total No.	mean No.	total No.	mean No.	total No.	mean No.	total No.	mean No.	total No.	mean No.
Deer mice	136	7.6	226	6.3	269	4.6	77	3.5	66	5.5
Least chipmunk	17	.9	21	.5	47	.8	23	1.0	24	2.0
Longtailed pocket mice	9	.5	32	.8	8	.2	10	1.7	4	T
Ord's kangaroo rat	1	T	5	.1	17	1.6				
Sagebrush vole			2	T						
Grasshopper mice			4	T						
Little pocket mice			2	T						
Pinyon mice			6	.1	3	T	22	2.2	1	T
Western harvest mice	3	T			1	T				
Longtailed vole					5	.4				
Longtailed weasel					1	T				
Rock squirrel					1	T				

was 21.3, while the mean number encountered the second season was 19.4. The fluctuations in birds observed was greater the second season (SD=22.9) than the first season (SD=11.1). Within both seasons the bird population had a positive skewness, (CS=1.4) the first season and (CS=.8) the second season. The bird population the first season had an above normal kurtosis value (CK=6.1), while the bird population the second season had a normal kurtosis value (CK=2.8).

Table 32 contains a categorization of the study area into burned, unburned, and ecotone areas with respective bird numbers encountered per transect in each category.

Significantly less birds were encountered on unburned than either burned or ecotone areas. More birds were encountered on ecotone areas the first season.

No significant difference was found between the number of bird species within seasons, between seasons, or between treatments (Table 33). The greatest number of bird species were encountered on burned areas.

A positive relationship (r^2=.74) was found between the number of hummingbirds sighted and the percent cover of flowering plants the first season. However, not enough hummingbirds were sighted the second season to enable the previously mentioned test to be conducted.

Table 32. The mean and total number of birds encountered per transect on burned, unburned, and ecotone areas the first and second seasons at study sites in the White River area Humboldt National Forest, Nevada.

	1974 Season		1975 Season		
	mean number	total number	mean number	total number	mean per treatment
Burned	69.2^{a}[1/]	346	43.3^{b}	1226	56.2^{c}
Unburned	41.9	514	35.7^{b}	391	38.8
Ecotone	83.0^{a}	83	36.0^{b}	219	59.5^{c}

[1/] Means with the same subscript within columns are not significantly different.

Table 33. The mean number of bird species encountered per transect on burned, unburned, and ecotone areas the first and second seasons at study sites in the White River area Humboldt National Forest, Nevada.

	1974 Season mean number	1975 Season mean number	mean per treatment
Burned	$10.2^{a1/}$	9.3^{b}	9.7^{c}
Unburned	9.3^{a}	8.6^{b}	8.9^{c}
Ecotone	9.0^{a}	9.0^{b}	8.5^{c}

1/ Means with the same subscript within columns are not significantly different.

A total of 35 bird species, representing six orders and 17 families were encountered during the study (Table 2 Appendix Q). The common bushtit (Psaltriparus minimums) was the most abundant bird encountered during the study, followed by Brewer's sparrows (Spizella breweri), mourning doves (Zenaidura macoura), rufous-sided towhees (Pipillo erythrophthalmus), mountain chickadees (Parus gambeli), chipping sparrows (Spizella passerina), purple finches (Carodacus purpurens), and common nighthawks (Chordeilus minor). Other bird species encountered were in comparatively small numbers (Table 34).

DISCUSSION

More rodents were caught per trapline the first season opposed to the second season. Less rodents were consistently captured on unburned areas throughout the study. However, more rodents were captured on ecotone areas the second season than either burned or unburned areas.

Throughout the study the diversity of rodent species was greater on unburned areas. During the first season ecotone areas had the next greatest rodent diversity followed by burned areas. The second season this was reversed and burned areas had a greater rodent diversity than did ecotone areas.

Table 34. The total and mean number of birds encountered per transect on burned, unburned, and ecotone areas on study sites in the White River area Humboldt National Forest, Nevada.

	1974				1975					
	Burned		Unburned		Burned		Unburned		Ecotone	
	total No.	mean No.	total No.	mean No.	total No.	mean No.	total No.	mean No.	total No.	mean No.
Mourning dove			1	T	185	4.2	14	.3	16	.4
Chipping sparrow	17	.9	28	1.4	81	1.8	13	.3	7	.2
Gray flycatcher			4	.2	18	.4	1	T	1	T
Mountain chickadee	39	1.9	34	1.7	36	.8	42	1.0	18	.4
Rufous-sided towhee	8	.4	43	2.2	57	1.3	37	.8	25	.6
Mountain bluebird	12	.6	12	.6	48	1.1	5	.1	6	.1
Hairy woodpecker	7	.4	7	.4	41	.9	3	.1	4	.1
Pinyon jay	11	.6	29	1.5	16	.4	32	.7	5	.1
Brewer's sparrow	70	3.5	12	.6	333	7.6			9	.2
Greentailed towhee	3	.2	6	.3	7	.2	4	.1	T	
Raven					5	.1				
Scrub jay	12	.6	27	1.4	14	.3	14	.3	4	.1
Common bushtit	93	4.7	225	11.3	168	3.8	136	3.1	33	.8
Lazuli bunting					5	.1	1	T		
Western kingbird					2	T				
Common nighthawk	22	1.1	54	2.7	16	.4	15	.3	1	T
Brewer's blackbird			10	.5	38	.9	10	.2	4	.1
Plain titmouse	1	T	20	1.0	6	.1	33	.8	5	.1
Robin					18	.4			2	.1
Sparrow hawk					4	.1			1	T
Roughwinged swallow	3	.2			2	T				
Purple finch	5	.3	9	.5	68	1.6	5	.1	27	.6
Gray vireo					2	.5			1	T
Black throated gray warbler	2	.1	3	.2			11	.3		
Lark sparrow	30	1.5	5	.3	17	.4	2	T		
Copper's hawk					3	.1				
Blue gray gnatcher			18	.9			16	.4		
Black throated sparrow			8	.4	1	T				
Red tailed hawk			3	.2	3	.1	3	.1		
Audubon's warbler	4	.2	15	.8	3	.1				
Hummingbird	12	.6	2	.1	7	.2				
Western tanager	10	.5	1	T			2	T		
Black chinned sparrow			13	.7						
Savanha sparrow	14	.7								
Pine siskin	7	.4								

More birds were encountered the first season than the second. Less birds were consistently encountered on unburned areas throughout the study. Generally, the greatest number of birds were encountered on ecotone areas. However, more birds were encountered on burned areas than ecotone areas the second season.

The overall bird diversity was greater the first season than the second. Bird diversity was greater on burned areas. Ecotone areas had the lowest bird diversity. However, the diversity was greater on ecotone areas than unburned areas the second season.

An indication of community stability can be achieved through an understanding of its occupants. Margaleaf (1968), while studying ecological succession, formulated some characteristics unique to the stability of a community at early and late stages of succession. In terms of diversity, severe or unstable habitats will be accompanied by low species diversity, while more stable habitats are characterized by higher diversity. Higher diversity is likewise coincided with a lower abundance of animals. Odum (1971) agrees with Margaleaf in his statement "the more complex the ecosystem the more stable the community."

The rodent population studied conforms with Margaleaf's findings. The burned areas, being at an earlier stage of succession, are more unstable habitats than unburned areas. Consequently, burned areas had consistently greater numbers of rodents caught and a lower species diversity than did unburned areas. This pattern also held true when each season was looked at separately. However, season two had less numbers and species of rodents captured per trapline than did season one.

The bird population studied does not conform with Margaleaf's findings. Bird numbers and species were consistently greater on burned versus unburned areas throughout the study. Bird numbers were greatest on ecotone areas, but the diversity was lower here than the other treatments. As with the rodent population the birds were more numerous and diverse on burned than unburned areas the first season. The bird population was more diverse but less abundant the second season on ecotone areas opposed to ecotone areas the first season.

Burning had a different effect on the rodent population than it had on the bird population. As mentioned, the rodent population increased in numbers but decreased in diversity, while the avifauna increased in both numbers and diversity on burned areas.

There was a greater variety and abundance of herbaceous plants on burned areas. This additional herbaceous vegetation created a larger number of microhabitats and a greater abundance of food. Hence a greater number and variety of animal species could be expected to occupy the burned areas. Birds having greater interhabitat movement were able to fill the newly created niches on burned areas more rapidly than rodents.

Basically, only one species of rodent, deer mice, established itself on burned areas in substantial numbers. The deer mouse is one of, if not, the most versatile native rodent species in the United States. Deer mice are known to be highly adaptable to moving back into freshly cleared areas and to be able to exist on a variety of foods. Deer mice were better able to cope with a habitat change from a pinyon-juniper dominated community to a grass and forb dominated community than any other rodent species encountered.

Other mammal species which benefited from burning were the least chipmunk, Ord's kangaroo rat, western harvest mouse, longtailed vole, longtailed weasel, and rock squirrel. Least chipmunks ventured farther out on burned areas, especially when no cover was present, than any other rodent species.

The first season ,Ord's kangaroo rats were present on both burned and unburned areas. The second season, however, they were found only on burned areas. This is probably due to the increase in seed producing plants on burned areas the second season. Western harvest mice were associated with dense stands of grasses and forbs. The longtailed voles were always caught in very dense forbs associated with water. Only one longtailed weasel was captured during the study. The weasel was captured at the same location as the majority of longtailed vole were captured. Ingles (1965) lists weasels as one of the chief predators of the vole. A rock squirrel was encountered only once during the study and this was on a burned area. Ahlgren (1966) stated that food was the primary factor in population fluctuations of small mammals after burning. Most mammal species encountered during this study on burned areas were granivorous, except for the weasel, which could have been present due to the increase in its prey species.

Longtailed pocket mice and pinyon mice were the most abundant rodent species on unburned areas. On unburned areas these species were associated with dense shrub and tree cover. When captured on burned areas, dense unburned cover was always nearby.

Twenty-eight bird species were encountered the first season. Twenty-one of these species were found to be using the burned areas, while 25 of the species were found to be using the unburned areas. Those species which were more abundant on burned areas the first season (Brewer's sparrow, rough-winged swallow, lark sparrow, savannah sparrow, pine siskin, hummingbirds, and western tanagers) were primarily ground, aerial, and nector feeders. Those species which were more common on unburned areas were canopy feeders in pinyon-juniper woodlands.

Of the 32 bird species encountered the second season 29 were found on burned areas. Once again seed eating birds were more common on burned areas.

Insectivorous birds were more prevalent on burned areas the second season than the first. The canopy feeders were still more common on unburned areas the second season as well. However, the common bushtit, a canopy feeder, was more common on burned than unburned areas the second season.

On burned areas more rodents were found to be using the areas that had greater percentages of grass and forb cover. This held true for both seasons. During the first season a positive relationship was found between the number of rodents and percent ground cover of flowering plants on burned areas. However, the same data the second season proved to be unrelated. No significant correlations were found to exist between the numbers and species of rodents with percent grass and forb cover on burned and unburned areas. However, the highest correlations were found to exist between rodent numbers and percent grass and forb cover on burned areas.

The positive relationship found between hummingbirds and percent cover of flowering plants could not be duplicated the second season even though the percent of flowering plants was significantly greater.

It is unclear as to what caused the overall population declines from year one to year two, expecially since the persent of flowering plants was greater the second year. Perhaps some other environmental factor or factors beyond the scope of this study had an overriding effect on the animal populations than prescribed burning.

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Appendix A

Table 1. Summary of percent ground cover on White River and Cherry Springs Plots.

Plots Nos.	Litter	Bare Ground	Rock	Pavement	Veg.
Upper White River					
1702-07	55[1/]	27	10	3	5
1710-20	52	31	5	10	3
1730-34	76	12	6	6	0
1711-15	58	32	1	3	6
1701-10	74	18	1	1	6
1721-24	78	18	0	0	4
1725-29	74	19	2	4	1
Middle White River					
1701-05	50	36	4	4	6
1929-33	50	35	4	9	2
1724-28	57	21	5	16	1
1706-08	73	16	T	3	8
1715-19	79	18	1	1	1
Lower White River					
1713-17	58	23	4	10	5
1708-12	46	25	3	22	4
1718-22	57	34	2	1	6
1723-27	45	37	3	12	3
1704-07	68	18	1	5	8
1701-03	82	9	0	1	8
Cherry Springs					
401-05	63	18	0	16	3
406-10	35	37	0	18	10
411-20	53	24	0	17	6

1/ Mean percentage from five plots.

Appendix B

Table 1 . Summary of mean pinyon counts by age class from .1 hectare plots at White River and Cherry Springs study areas.

Plot No.	Seedling	Young Sapling	Sapling	Mature Vigorous	Mature Old	Dec.
Upper White River						
17-02-07	14.4[1]	16.2	11.6	8.2	.6	.2
17-16-20	6.4	6.4	7.4	7.6	1.2	.2
17-30-34	9	14	14	9	6	0
17-11-15	1.4	7.6	10.8	16.2	.8	0
17-01-10	7.8	8.4	21.4	11.0	1.4	0
17-21-24	3.4	4	9.4	15.2	3.4	1.2
17-25-29	2	1.4	4.4	15.8	5	1.2
Middle White River						
1701-05	9.6	12.6	16.6	5.4	1.8	0
1729-33	1.4	5.2	5.6	6.4	.4	.2
1724-28	8.4	14	16.8	17.4	8	.8
1706-08	2.6	7	22.6	1.3	.3	0
1715-19	.6	.2	8.8	19	9.8	0
Lower White River						
1713-17	1.2	3.4	7.6	5.2	.6	0
1708-12	.4	3	5.4	2.6	.2	0
1718-22	0	.2	0	0	0	0
1723-27	.6	1	2.2	1	0	0
1704-07	4.5	2.5	4	.2	0	0
1701-03	.6	1	9	2	0	0
Cherry Springs						
401-05	.8	5	8.2	15.0	1.8	3.2
406-10	.4	.2	.2	.4	.2	.2
411-20	1	4.6	7.6	9.9	.8	.2

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[1] Mean number from five plots

Appendix B

Table 2. Summary of mean juniper counts by age class from .1 hectare plots at White River and Cherry Springs study areas.

Plot No.	Seedling	Young Sapling	Sapling	Mature Vigorous	Mature Old	Dec.
Upper White River						
17-02-07	2.2[1/]	5.2	5	3.4	.2	0
17-16-20	4.8	14.6	16.4	17.8	1.4	.2
17-30-34	4	8	10	15	1	0
17-11-15	1.6	10.4	8.8	7.8	0	.4
17-01-15	1	3.2	12.4	3.2	1	0
17-21-24	.2	1	2.4	4.6	.2	.4
17-25-29	.2	2	3.8	7.6	1.4	.4
Middle White River						
1701-05	4.8	8.6	9.2	1.6	.8	0
1729-33	.2	2.6	5	4	0	0
1724-28	2.2	4	13	10.4	2.4	.8
1706-08	1.3	2.3	21.3	3	.3	0
1715-19	0	.6	5.2	13.6	1.2	1.2
Lower White River						
1713-17	1	5.4	6.6	5	.6	0
1708-12	.4	4	7.6	3.6	0	0
1718-22	0	2.6	8.6	6.8	.2	.6
1723-27	.4	5.4	10.6	8.4	1	.2
1704-07	2.7	4	10	.7	.2	0
1701-03	.3	.6	6	1.3	0	.3
Cherry Springs						
401-05	2	4.8	7.4	26.8	3.2	3.4
406-10	1.6	5.2	7.4	35.4	10.4	5.8
411-20	1.6	3.9	10.5	15	3.3	1.1

[1/] Mean number from five plots

Appendix C

Table 1. Estimated mean green shrub weight in grams per square meter on pre-burn plots at White River, Cherry Springs and Blackwell Canyon study sites. (Mean is derived from 20 one square meter samples per plot.)

	SPECIES					WEIGHT	
	Live Artr1/	Dead Artr	Live Pugl2/	Dead Pugl	Live Chvi3/	Kilograms/ha.	Pounds/a.
WHITE RIVER							
17-02U	433	25	185	5	28		
17-03U	500	28	823	510	10		
17-06U	193	0	250	70	5		
17-07U	473	30	478	35	8		
$\bar{X}$ gram/m^2	400	21	434	155	13	10,230	9,148
17-11U	806	704	329	102	0		
17-12U	352	227	397	284	0		
17-13U	579	204	204	23	0		
17-14U	170	91	34	79	0		
17-15U	624	250	102	0	0		
$\bar{X}$ gram/m^2	506	295	213	98	0	11,120	9,932
17-16U	535	110	1068	5	5		
17-17U	508	0	415	0	15		
17-18U	368	25	520	0	3		
17-19U	115	78	78	0	0		
17-20U	333	190	270	53	0		
$\bar{X}$ grams/m^2	372	33	470	12	5	5,980	5,358
17-21U	0	646	125	0	0		
17-22U	6	68	425	510	193		
17-23U	0	510	181	170	0		
17-24U	221	108	312	34	3		
$\bar{X}$ grams/m^2	57	333	261	179	49	8,790	7,841

1/ Artemisia tridentata
2/ Purshia glandulosa
3/ Chrysothamnus viscidiflorus

Table 1. (Cont'd)

	SPECIES					WEIGHT	
	Live Artr[1/]	Dead Artr	Live Pugl[2/]	Dead Pugl	Live Chvi[3/]	Kilograms/ha.	Pounds/a.
WHITE RIVER (Cont'd)							
17-30U	159	148	0	0	0		
17-31U	139	170	0	0	0		
17-32U	170	91	0	0	0		
17-33U	34	91	45	34	0		
17-34U	23	57	45	79	11		
$\overline{X}$ grams/m^2	105	111	18	23	2	2,590	2,352
17-01m	241	63	188	0	53		
17-02m	118	68	83	0	75		
$\overline{X}$ grams/m^2	180	66	136	0	64	4,460	4,007
17-06m	692	182	556	0	45		
17-07m	102	306	624	341	0		
$\overline{X}$ grams/m^2	397	244	590	171	23	14,020	12,502
17-15m	454	1135	545	772	23		
17-17m	136	0	272	114	0		
17-18m	0	11	216	681	0		
17-19m	68	533	885	45	134		
$\overline{X}$ grams/m^2	165	165	480	403	39	12,520	11,194
17-24m	0	0	0	22			
17-25m	162	12	10	0			
17-26m	108	93	108	20			
17-27m	78	65	85	15			
17-28m	118	88	78	15			
$\overline{X}$ grams/m^2	93	52	56	16	0	2,130	1,830

Table 1. (Cont'd)

	SPECIES					WEIGHT	
	Live Artr[1/]	Dead Artr	Live Publ[2/]	Dead Pugl	Live Chvi[3/]	Kilograms/ha.	Pounds/a.
WHITE RIVER (Cont'd)							
17-29m	157	23	118	13	0		
17-30m	298	68	120	0	25		
17-31m	195	60	145	43	73		
17-32m	358	70	55	3	38		
17-33m	370	88	68	3	33		
$\overline{X}$ grams/m^2	276	62	101	12	34	4,850	4,356
17-01L	1816	431	1612	409	0		
17-02L	1317	681	1385	660	0		
17-03L	1657	704	182	636	272		
$\overline{X}$ grams/m^2	1597	605	1060	568	91	39,210	36,154
17-08L	785	31	63	15	25		
17-09L	805	208	148	15	58		
17-10L	273	23	215	3	15		
17-11L	485	100	103	3	10		
17-12L	898	8	373	25	25		
$\overline{X}$ grams/m^2	649	74	108	12	27	9,420	8,624
17-13L	710	150	293	0	35		
17-15L	585	83	128	5	4		
17-16L	738	10	383	195	15		
$\overline{X}$ grams/m^2	678	81	268	7	18	10,520	9,365
17-18L	453	103	53	5	30		
17-19L	605	158	60	5	90		
17-20L	1085	70	225	-	45		
17-21L	375	368	253	-	28		
$\overline{X}$ grams/m^2	630	175	148	3	48	10,040	9,189

Table 1. (Cont'd)

	SPECIES					WEIGHT	
	Live Artr[1/]	Dead Artr	Live Pugl[2/]	Dead Pugl	Live Chvi[3/]	Kilograms/ha.	Pounds/a.
WHITE RIVER (Cont'd)							
17-23L	499	284	34	11	77		
17-24L	765	147	113	34	34		
17-25L	595	23	113	0	17		
17-26L	595	11	159	0	17		
17-27L	176	28	113	0	113		
$\overline{X}$ grams/m^2	526	99	106	9	52	7,920	6,970
17-28L	545	227	114	11	45		
17-29L	68	125	227	91	0		
17-30L	352	363	74	0	0		
17-31L	509	499	45	0	0		
$\overline{X}$ grams/m^2	369	304	115	26	11	8,250	7,492
CHERRY SPRINGS							
4-01	0	0	0	0	0		
4-02	0	0	0	0	45		
4-03	0	0	0	11	0		
4-04	0	0	0	23	23		
4-05	0	0	0	0	0		
$\overline{X}$ grams/m^2	0	0	0	7	13	210	200
4-06	0						
4-07	0						
4-08	0	11	0	0	68		
4-09	0	22	0	0	22		
4-10	0	22	0	0	147		
$\overline{X}$ grams/m^2	0	11	0	0	47	580	523

Table 1. (Cont'd)

	SPECIES					WEIGHT	
	Live Artr[1]	Dead Artr	Live Pugl[2]	Dead Pugl	Live Chvi[3]	Kilograms/ha.	Pounds/a.
CHERRY SPRINGS (Cont'd)							
4-11	62	113	0	45	91		
4-12	7	397	0	115	0		
4-13	0	442	0	0	79		
4-14	45	6	23	68	40		
4-15	113	215	23	91	57		
4-16	0	57	11	136	0		
4-17	23	170	0	11	0		
4-18	11	408	0	136	102		
4-19	113	193	45	11	102		
4-20	0	238	11	0	0		
$\overline{X}$ grams/m^2	37	224	11	61	47	3,800	3,485
BLACKWELL CANYON							
B-1	539	199	380	329	11		
B-2	619	136	23	0	125		
B-3	153	193	386	0	0		
B-4	380	0	448	0	0		
B-5	556	125	266	0	0		
B-6	165	17	17	11	0		
$\overline{X}$ grams/m^2	482	134	304	2	25	9,470	8,598

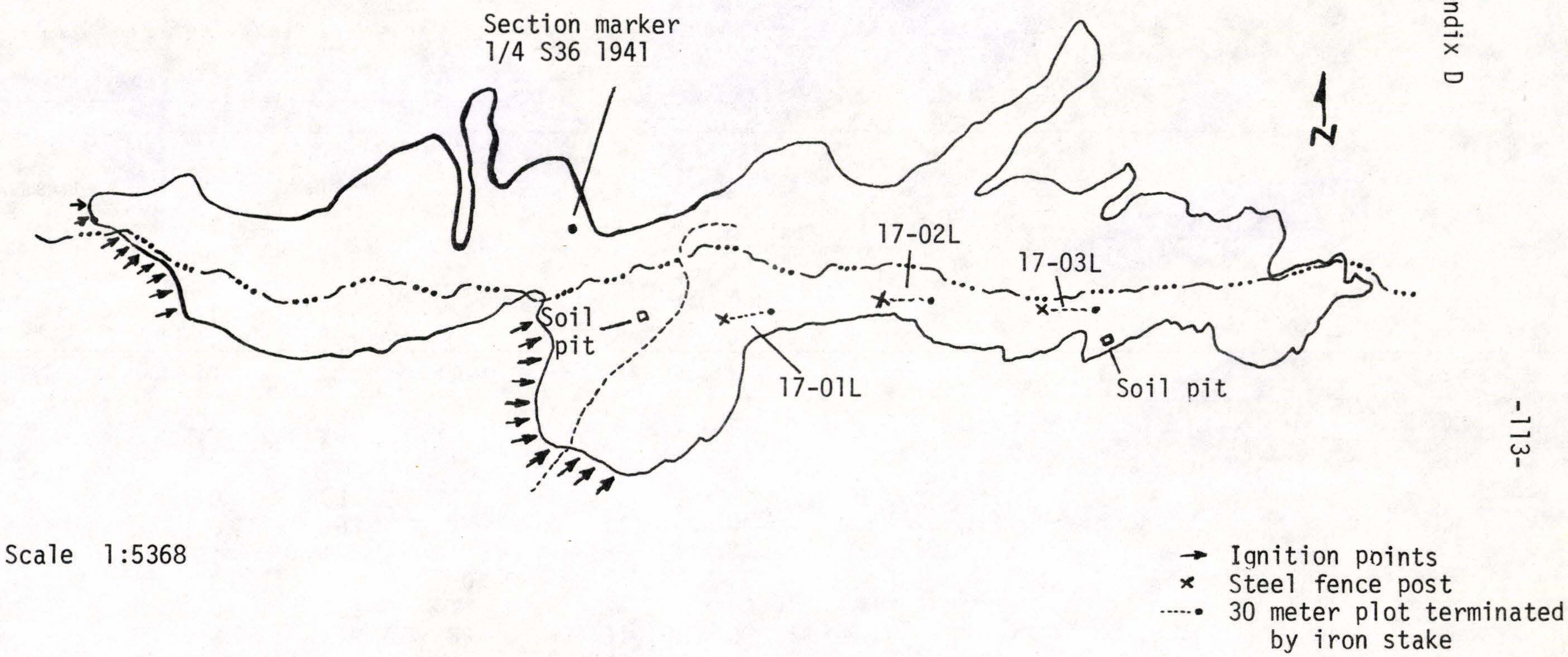
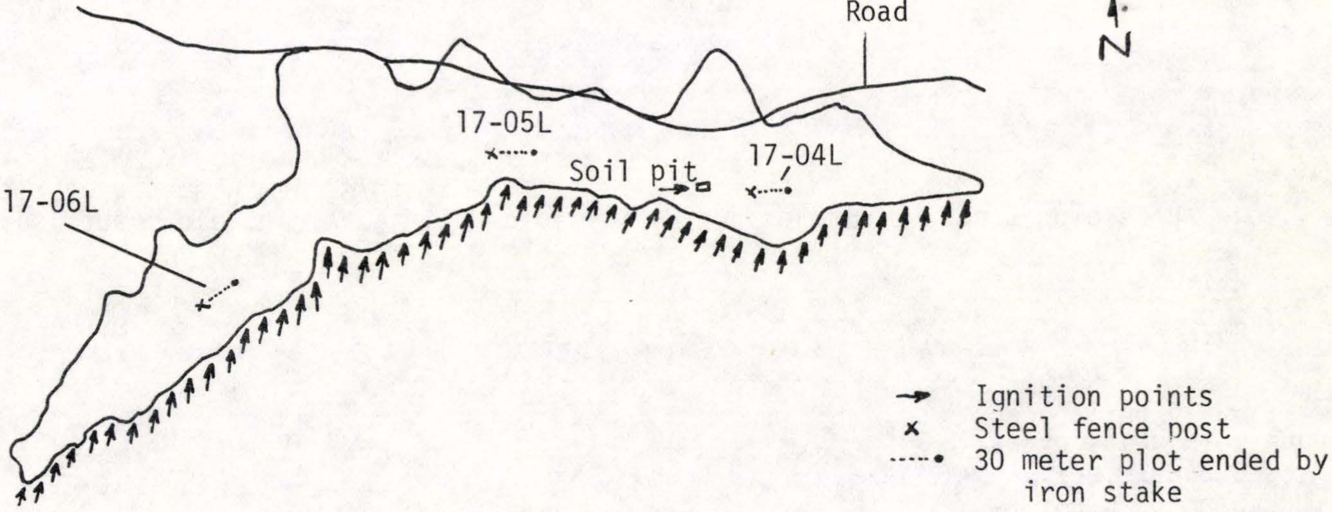

Section marker
1/4 S36 1941
17-02L
17-03L
Soil pit
17-01L
Soil pit
N
Scale 1:5368
→ Ignition points
× Steel fence post
----• 30 meter plot terminated by iron stake

Figure 1. Location of permanent pre-burn vegetation plots on an 18 acre burn in the lower study site at White River, Nevada. Burn date 24 April 1975.


Road
N
17-05L
Soil pit
17-04L
17-06L
Ignition points
Steel fence post
30 meter plot ended by iron stake

Scale 1:4000

Figure 2. Location of permanent pre-burn vegetation plots on an 8 acre burn in the lower study area at White River, Nevada. Burn date 9 October 1975.

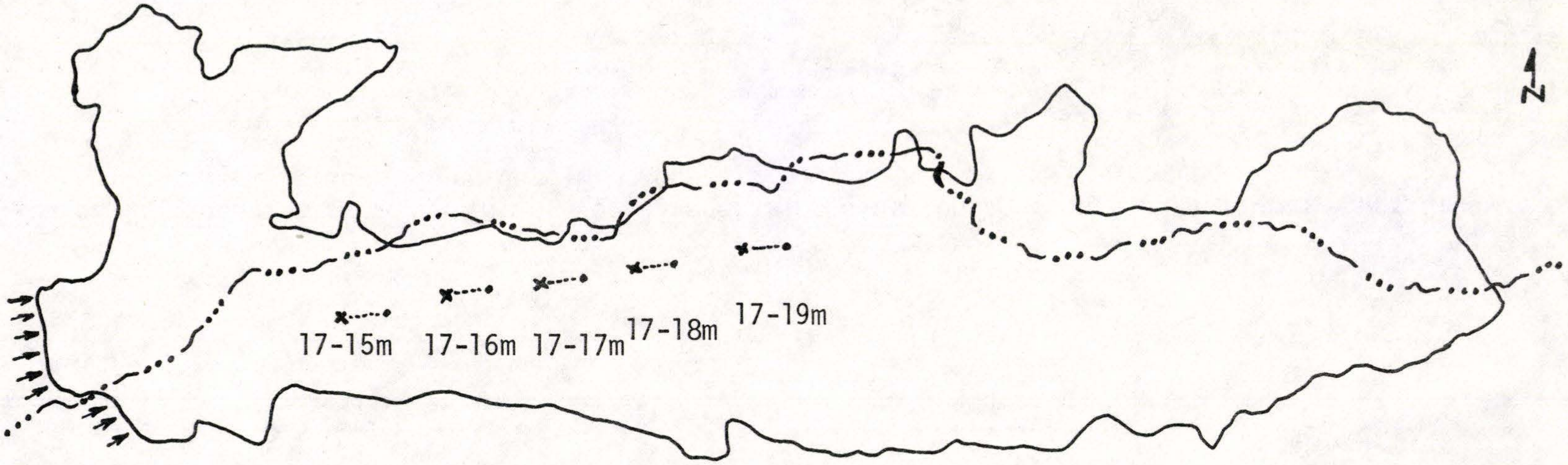

N
17-15m
17-16m
17-17m
17-18m
17-19m
Scale 1:4222
→ Ignition points
× Steel fence post
······• 30 meter plot ended by iron stake

Figure 3. Location of permanent pre-burn vegetation plots on a 19 acre burn in the middle study area at White River, Nevada. Burn date 9 May 1975.

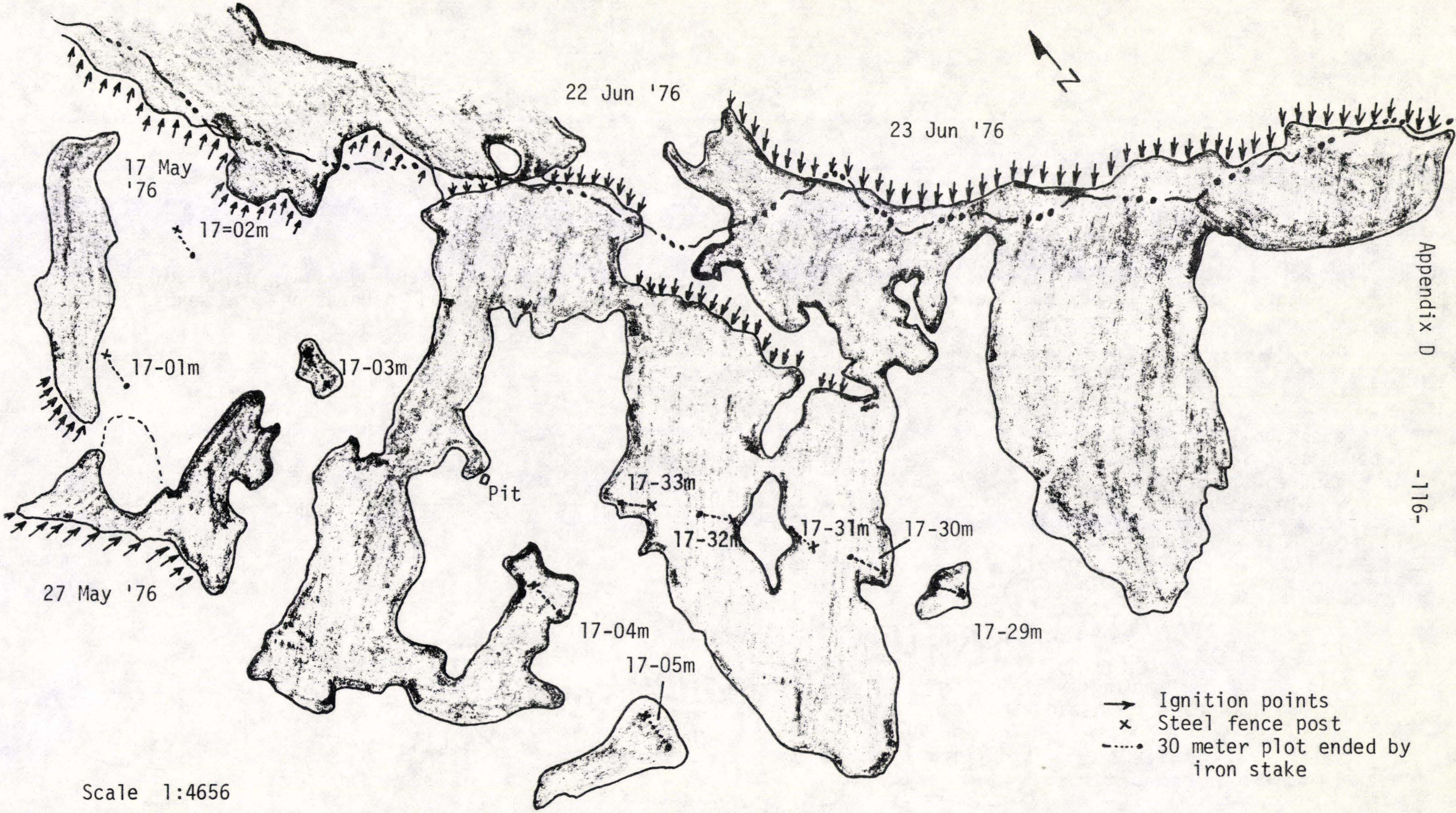

N
22 Jun '76
23 Jun '76
17 May '76
17=02m
17-01m
17-03m
27 May '76
Pit
17-33m
17-32m
17-31m
17-30m
17-29m
17-04m
17-05m
Ignition points
Steel fence post
30 meter plot ended by iron stake
Scale 1:4656

Figure 4. Location of permanent pre-burn vegetation plots on a 70 acre burn in the middle study area at White River, Nevada. Burn dates shown at ignition points.

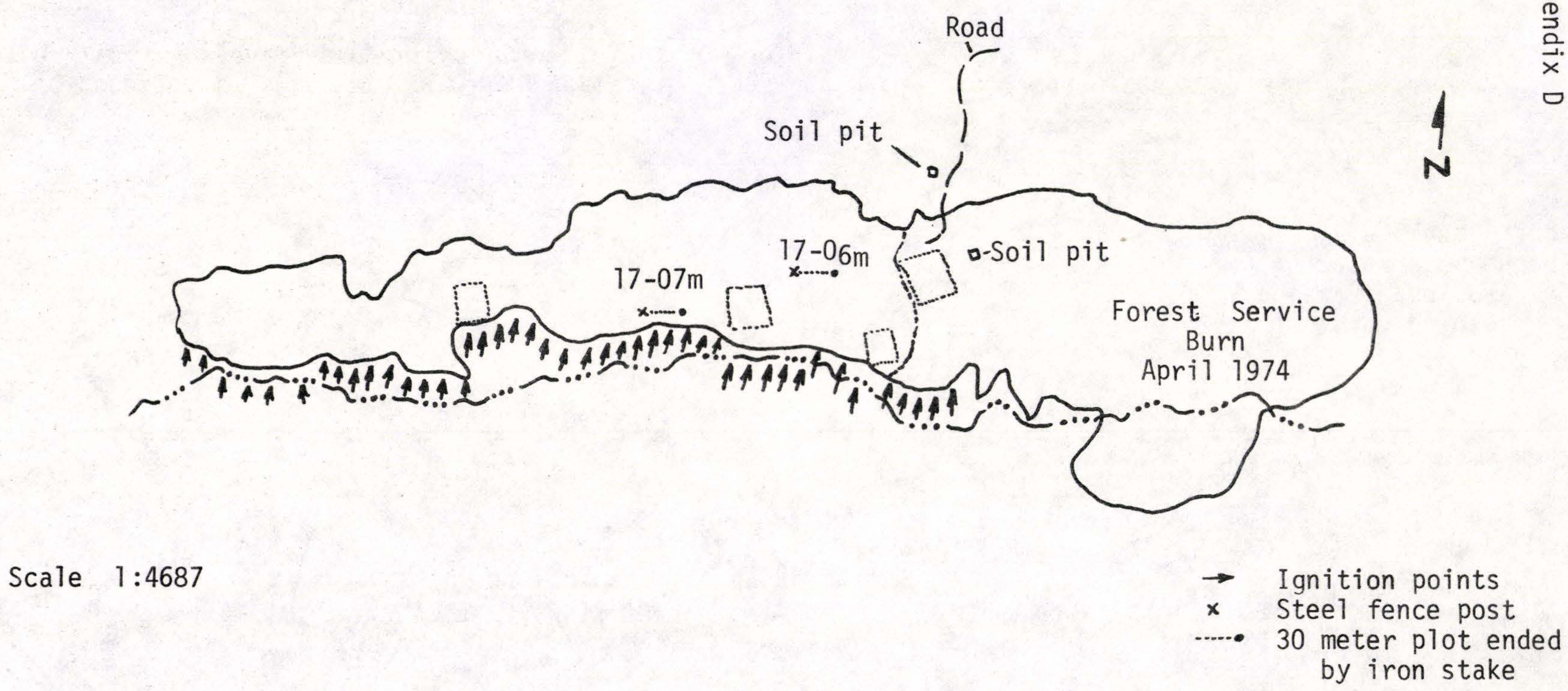

Road
Soil pit
N
17-06m
Soil pit
17-07m
Forest Service
Burn
April 1974
Scale 1:4687
Ignition points
Steel fence post
30 meter plot ended
by iron stake

Figure 5. Location of permanent pre-burn vegetation plots on a 9 acre burn in the middle study area of White River, Nevada. Burn date 3 May 1975.

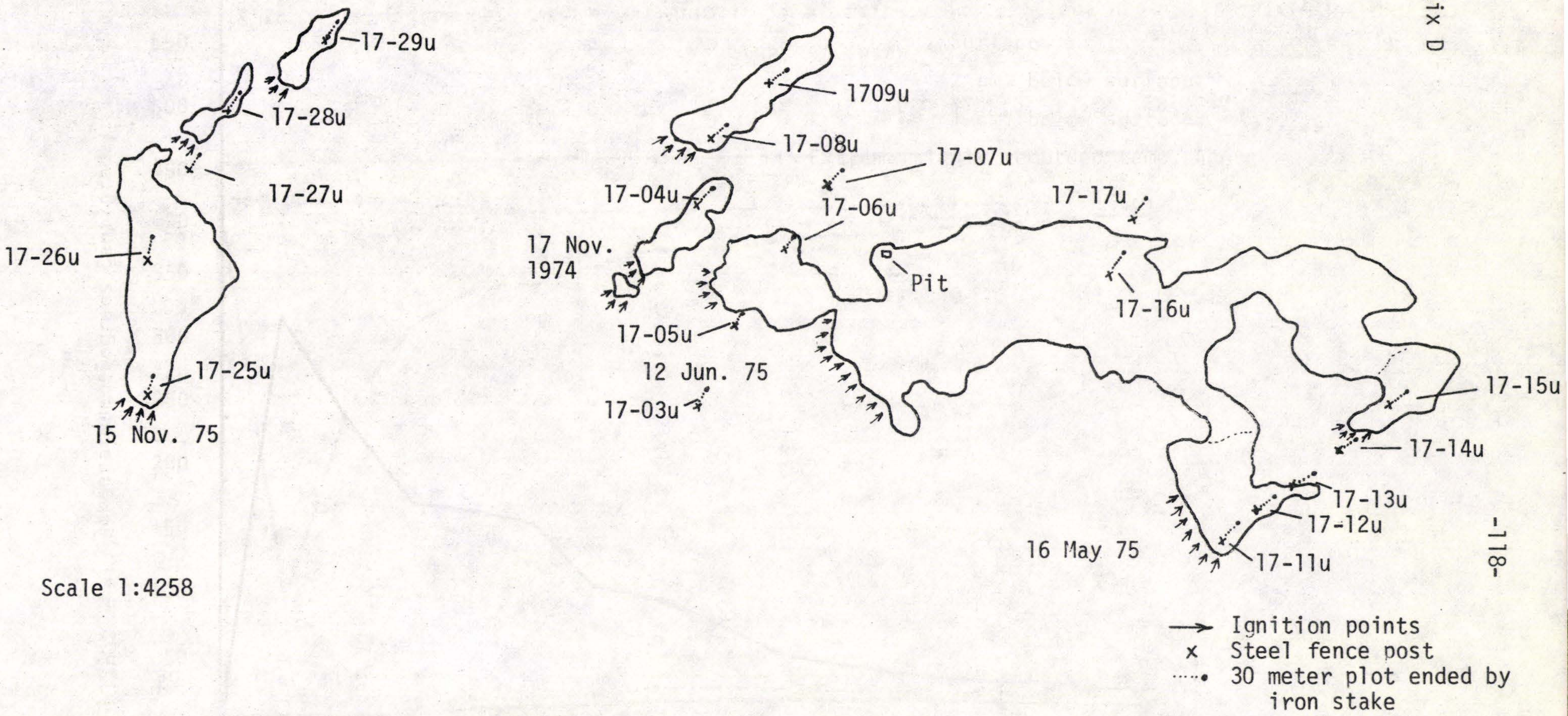

17-29u
17-28u
17-27u
17-26u
17-25u
15 Nov. 75
1709u
17-08u
17-07u
17-04u
17-06u
17-17u
17 Nov.
1974
Pit
17-16u
17-05u
12 Jun. 75
17-03u
17-15u
17-14u
17-13u
17-12u
16 May 75
17-11u
Scale 1:4258
Ignition points
Steel fence post
30 meter plot ended by iron stake

Figure 6. Location of permanent pre-burn vegetation plots on three burns in the upper study site at White River, Nevada. Burn dates shown at ignition points. Fifteen acres burned.

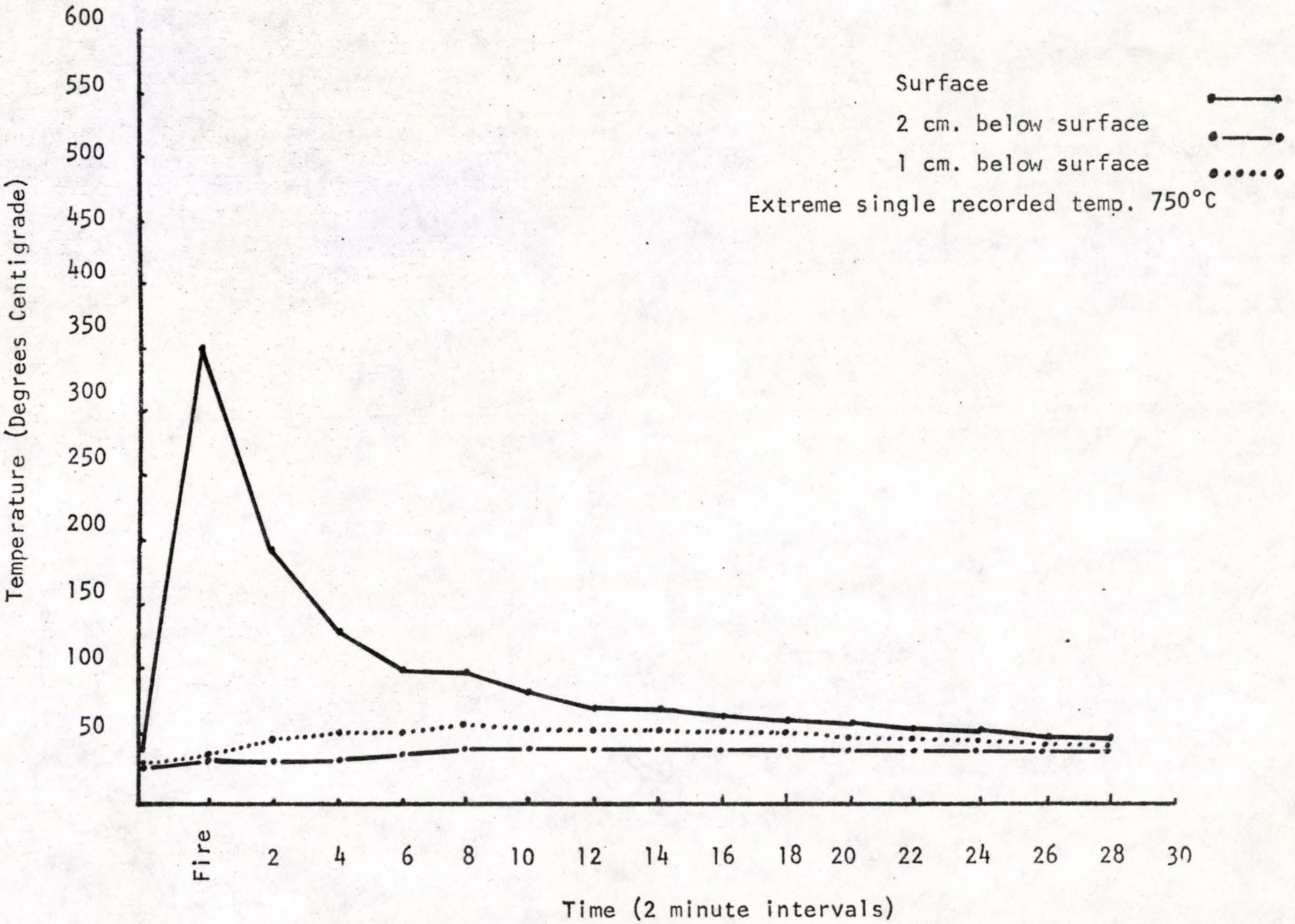


Figure 1. Mean temperatures from thermal couples at three positions under live bitterbrush canopies during April 24, 1975, fire, lower White River, Nevada.

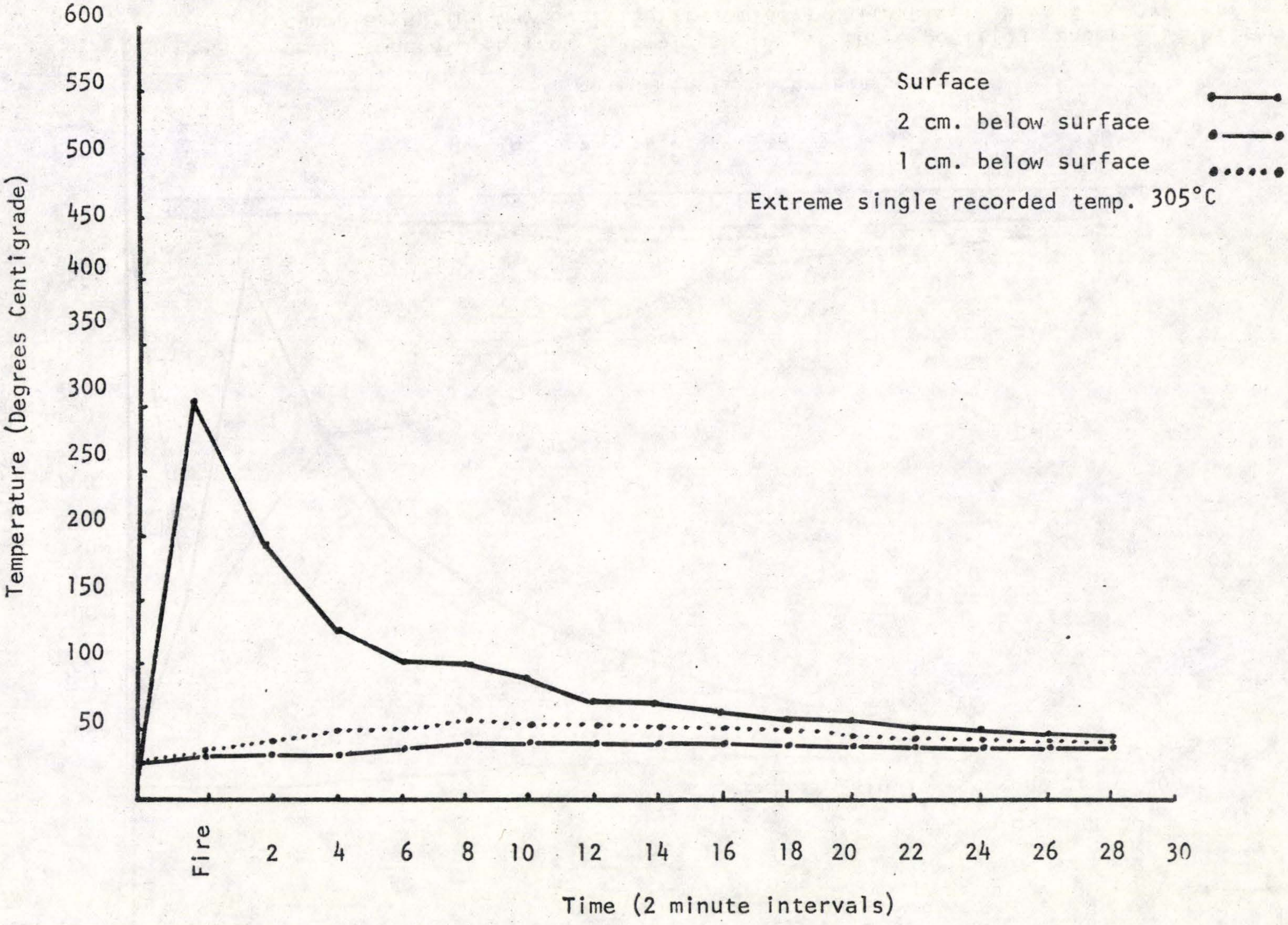
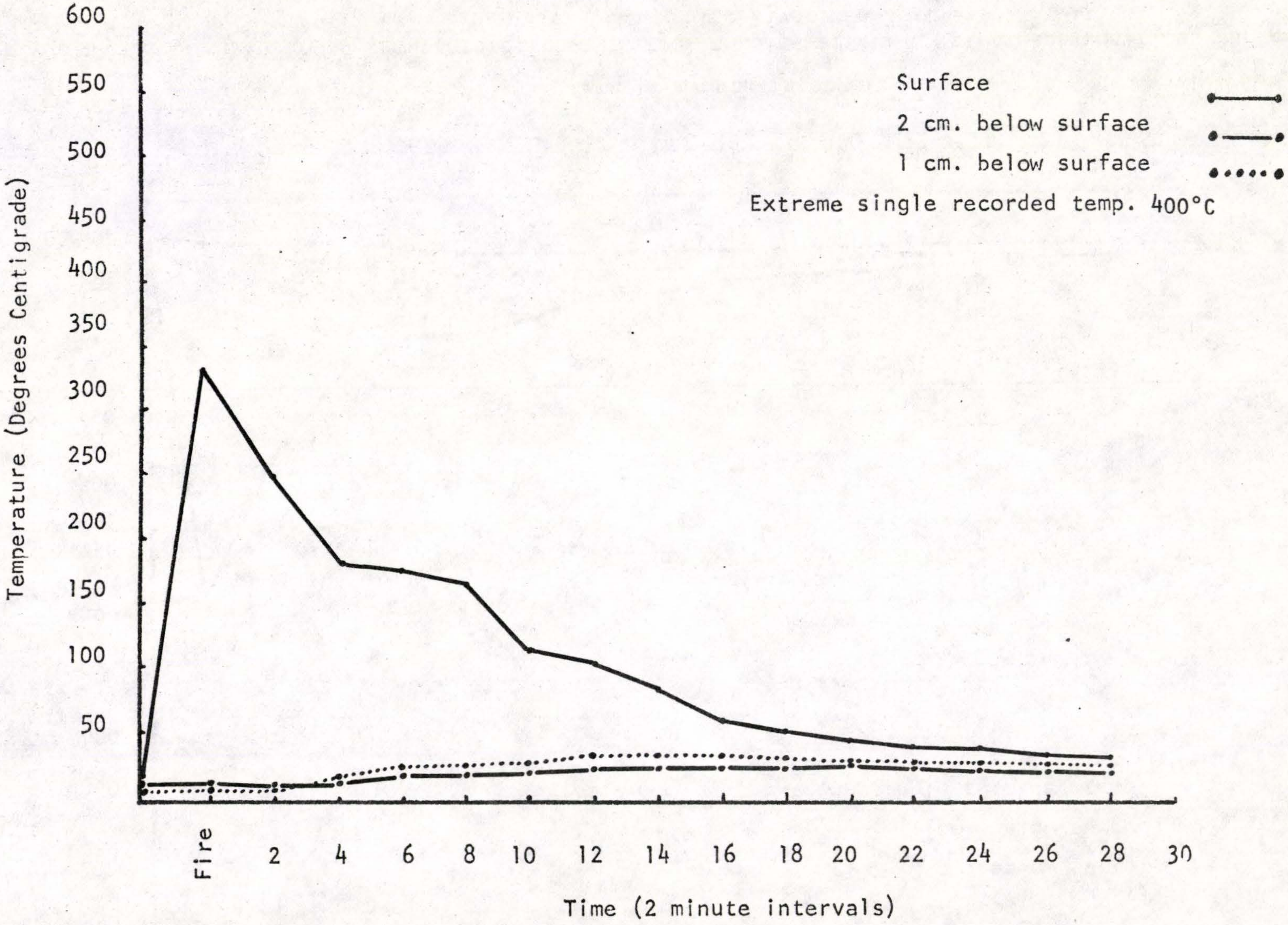


Figure 2. Mean temperatures from thermal couples at three interspace positions during April 24, 1975, fire, lower White River, Nevada.



Extreme single recorded temp. 400°C

Figure 3. Mean temperatures from thermal couples at three positions under live bitterbrush canopies during May 3, 1975 fire, middle White River, Nevada.

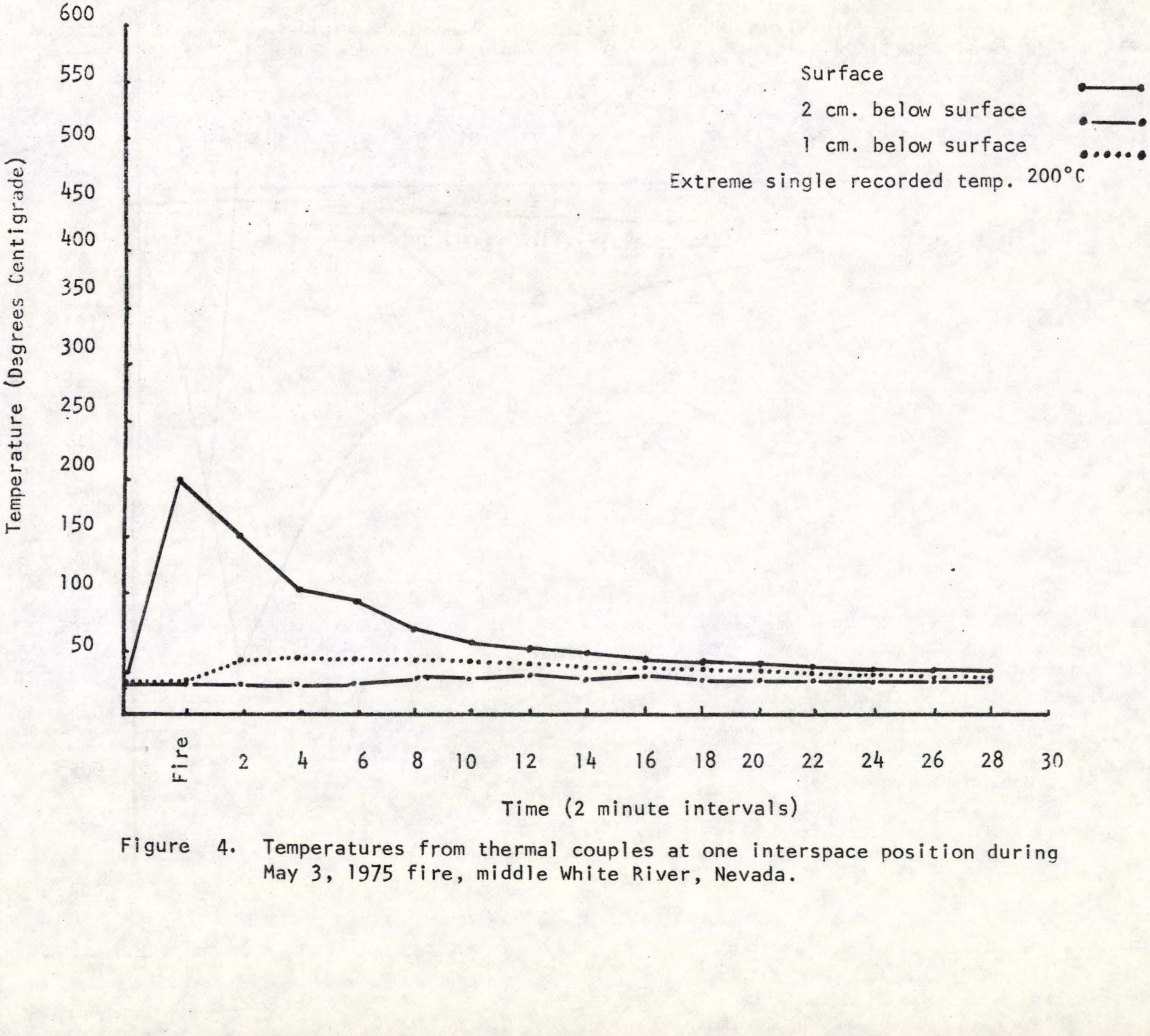


Figure 4. Temperatures from thermal couples at one interspace position during May 3, 1975 fire, middle White River, Nevada.

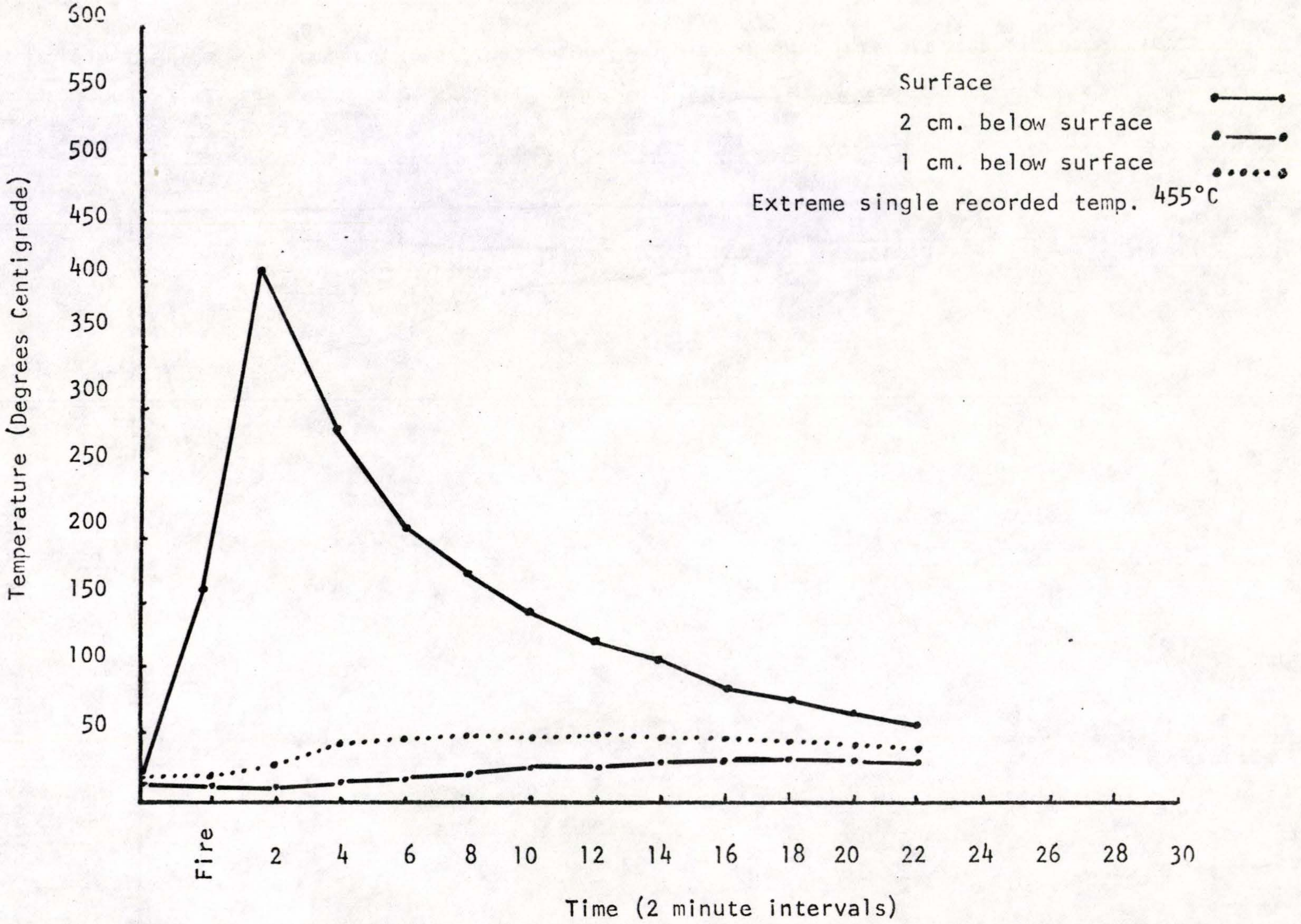


Figure 5. Mean temperatures from thermal couples at three positions under live bitterbrush canopies during May 16, 1975 fire, upper White River, Nevada.

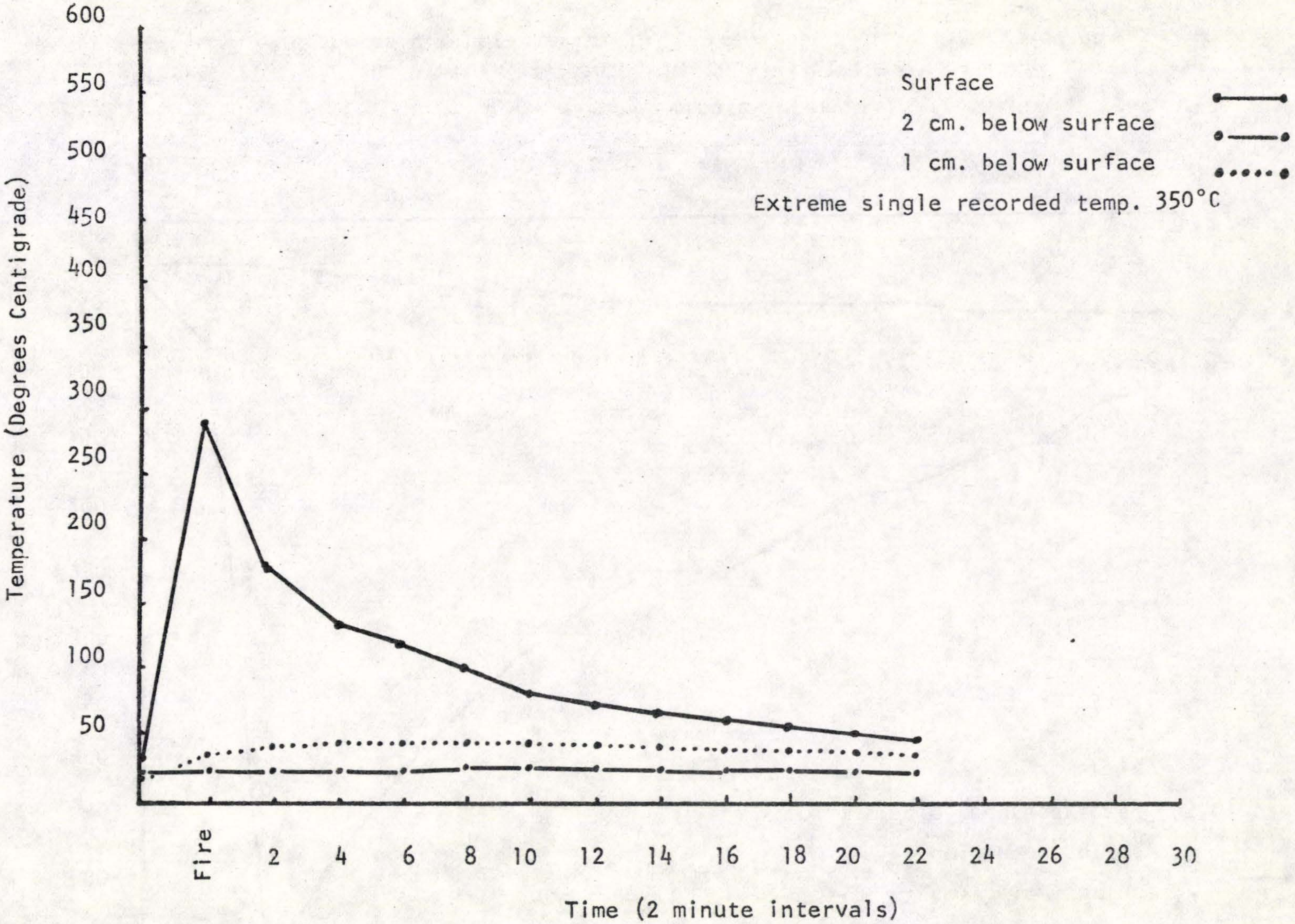


Figure 6. Mean temperatures from thermal couples at three interspace positions during May 16, 1975 fire, upper White River, Nevada.

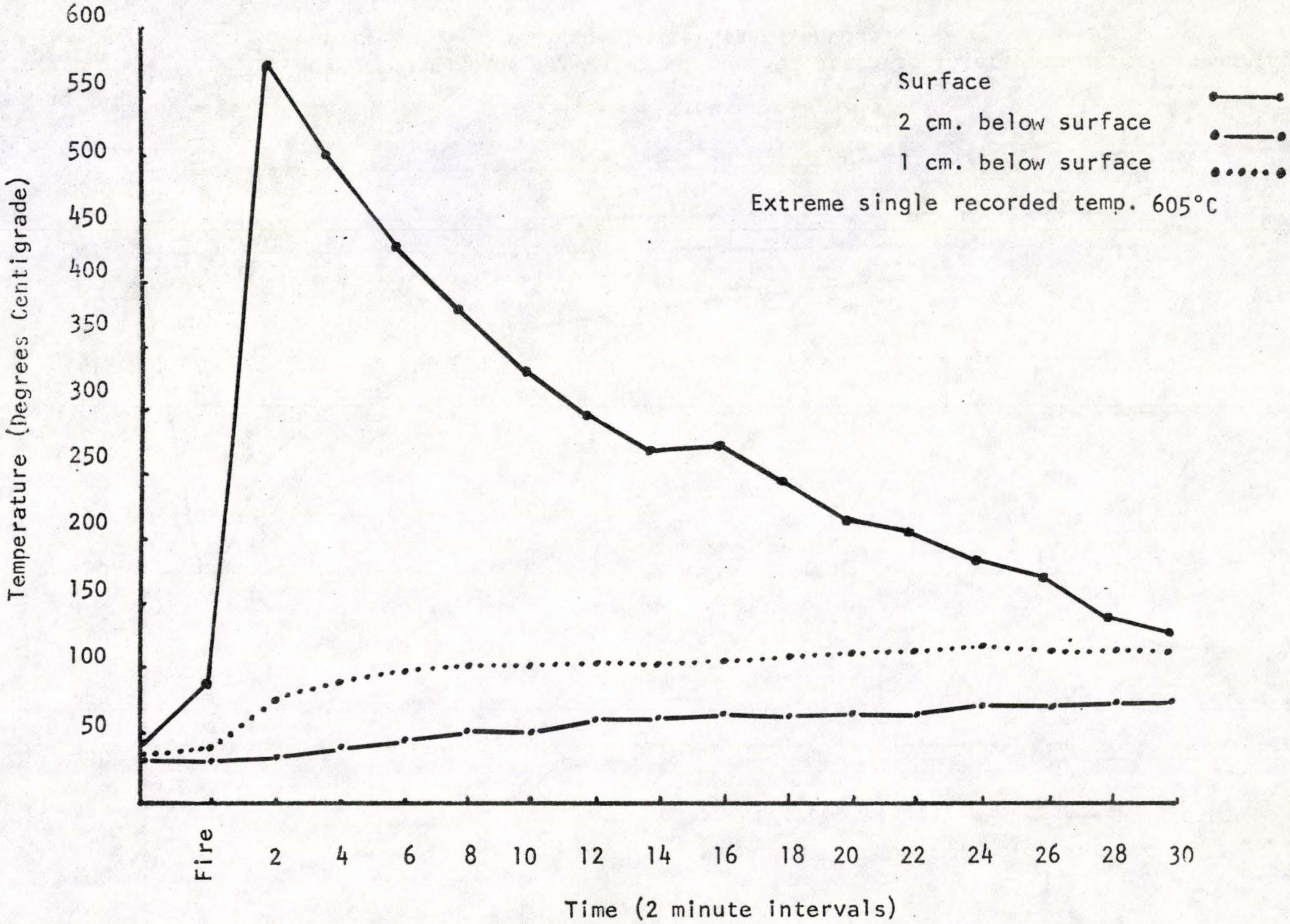


Figure 7. Mean temperatures from thermal couples at three positions under live bitterbrush canopies during June 12, 1975 fire, upper White River, Nevada.

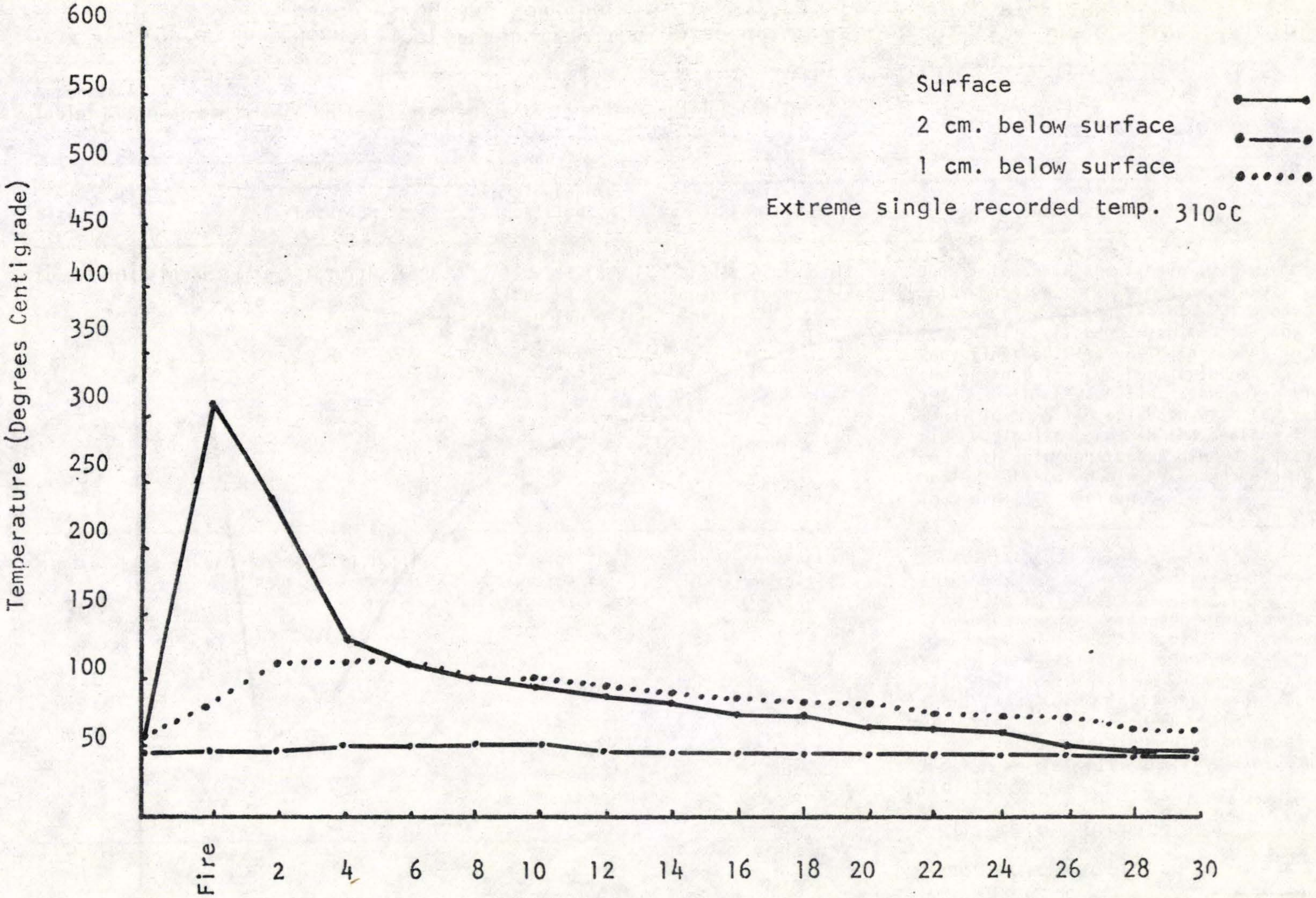


Figure 8. Temperatures from thermal couples at one interspace position during June 12, 1975 fire, upper White River, Nevada.

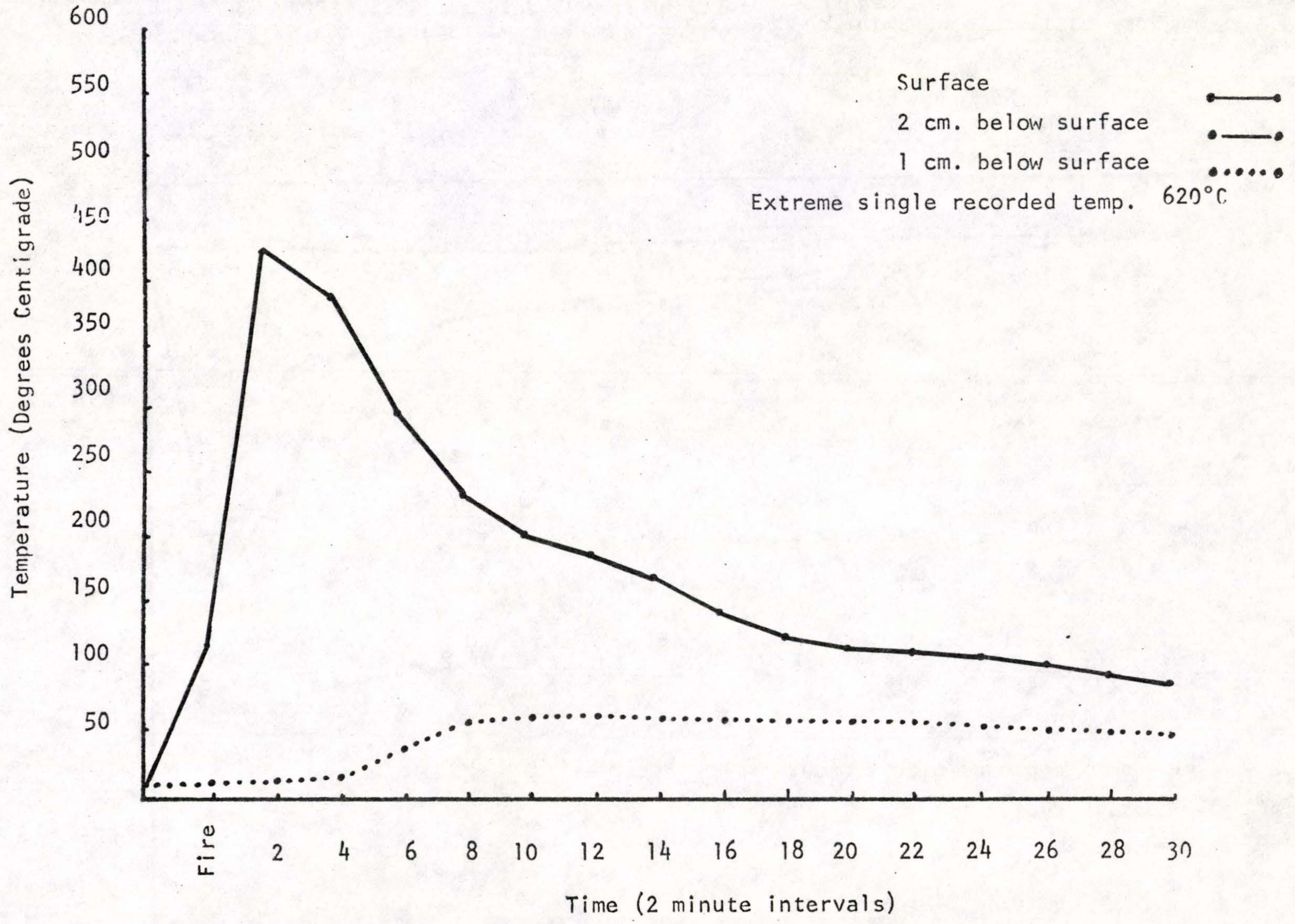
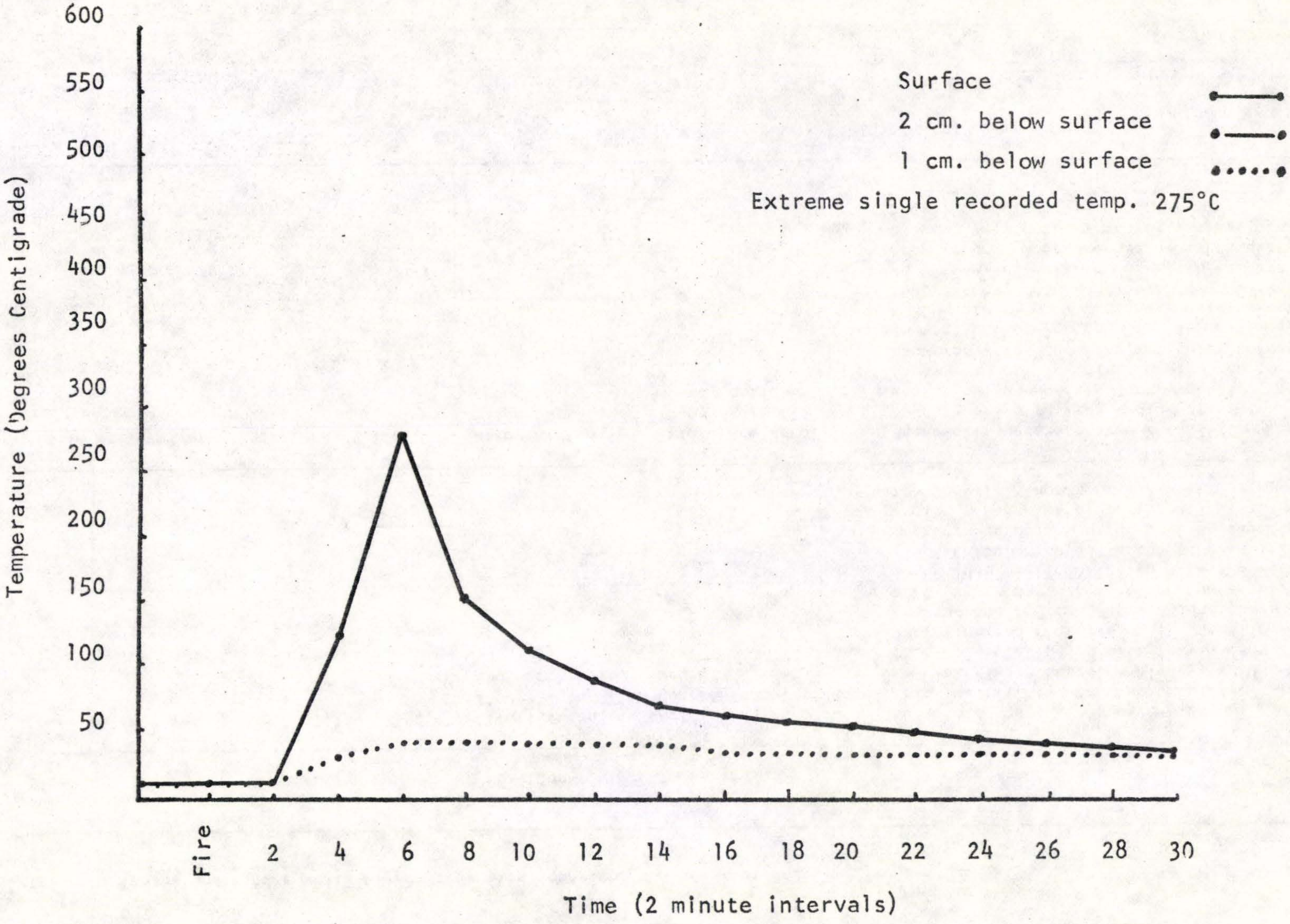


Figure 9. Mean temperatures from thermal couples at two positions under live bitterbrush canopies during November 15, 1975 fire, lower White River, Nevada.



Extreme single recorded temp. 275°C

Figure 10. Temperatures from thermal couples at one interspace position during November 15, 1975, upper White River, Nevada.

Appendix F.
Table 1. Lower and middle White River study site locations and descriptions.

Site	Location	Physiographic Position	Soil Family	Soil Description	Percent Vegetation Cover	
					Trees	Shrubs
Lower White River	Sec.36,T.11N.,R59E.	Alluvial fan. Slope 5% to the north-east.	Aridic Argixeroll, coarse-loamy, mixed, mesic	Dune interspace areas have a 20 -cm thick massive to weak medium platy to weak fine subangular blocky, sandy loam mollic epipedon with few to many very fine and fine vesicular pores in the surface 1-5 cm. Coppice dunes have a 20 -cm thick weak fine subangular blocky sandy loam mollic epipedon with few very fine vesicular pores in the surface 1-2 cm. Both epipedons occur over a moderate medium subangular blocky, sandy clay loam argillic horizon.	6	55
Middle White River	Secs.22&23,T.11N., R59E.	Alluvial fan. Slope 8% to the east.	Aridic Argixeroll, loamy-skeletal, mixed, mesic	Dune interspace areas have a 13-20 -cm thick massive to weak medium platy to weak fine subangular blocky, cobbly sandy loam mollic epipedon with few to many very fine and fine vesicular pores in the surface 1-6 cm. Coppice dunes have a 20 -cm thick weak fine subangular blocky, cobbly sandy loam mollic epipedon with few very fine vesicular pores. Both epipedons occur over a moderate medium subangular blocky, very cobbly, gravelly clay loam argillic horizon.	7	48

Appendix G

Table 1. Vesicular horizon development rating system.[1]

Soil Description	Ratings For Horizon Thicknesses 1 cm	2 cm	3 cm	4 cm	5 cm
1. No vesicular pores; well-aggregated, granular structure	1	1	1	1	1
2. Less than 1 vesicular pore/cm^2 or more than 1 pore/cm^2 and more than 90% of pores are less than or equal to 1 mm in diameter	2	2	3	3	3
3. More than 1 pore/cm^2 and 10 to 50% of pores are greater than or equal to 1 mm in diameter and less than 25% of pores are greater than or equal to 2 mm in diameter	2	3	3	4	4
4. More than 1 pore/cm^2 and more than 50% of pores are greater than or equal to 1 mm in diameter and/or more than 25% of pores are greater than or equal to 2 mm in diameter	3	3	4	4	5

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[1] Rating system applys only to Aridic Argixerolls on lower and middle White River study sites.

Appendix H

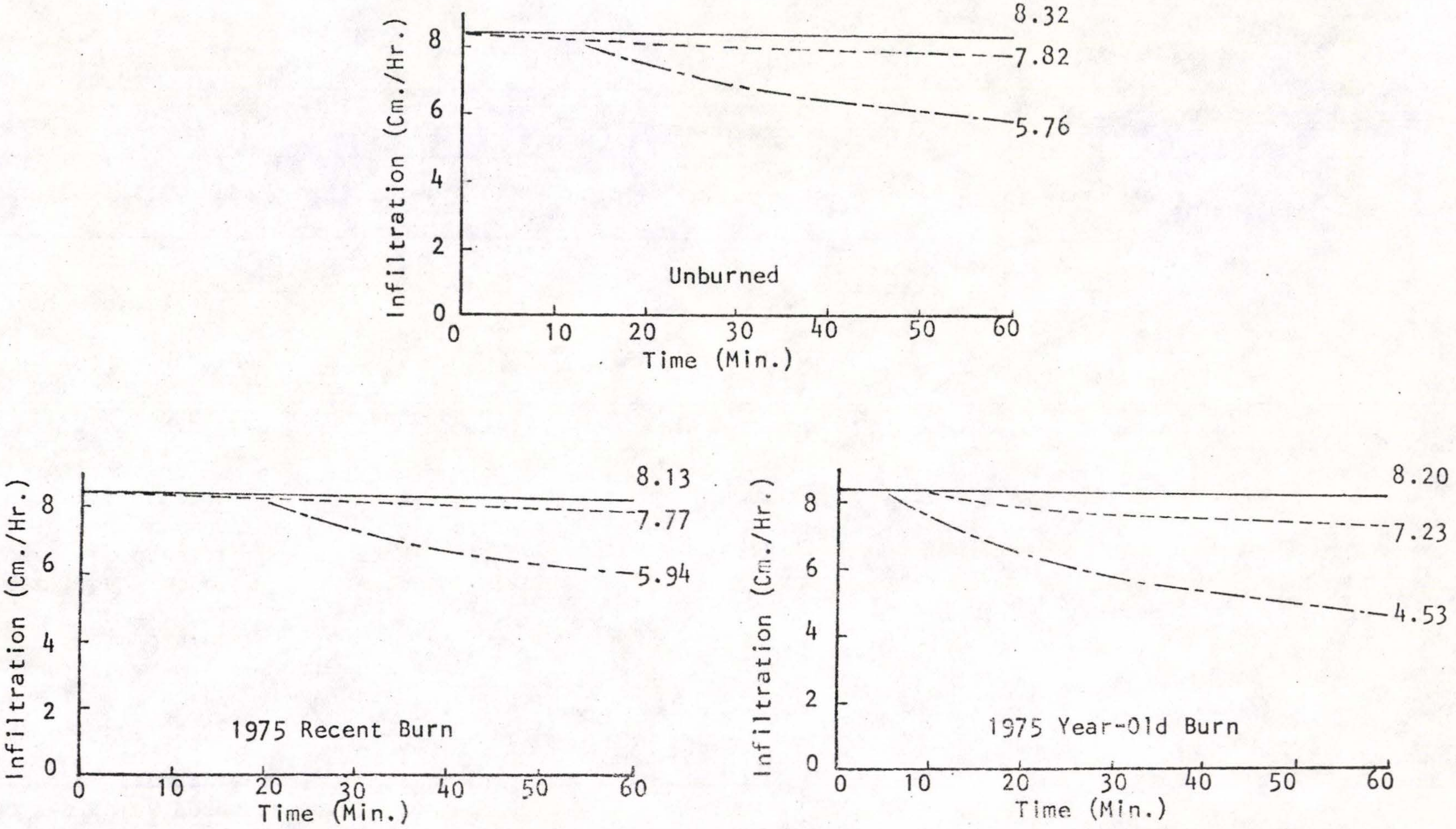

Figure 1. Infiltration curves for unburned and burned treatments, soil initially dry, lower White River, Nevada. Tree coppice =———; shrub coppice =------; interspace =—·—·—.

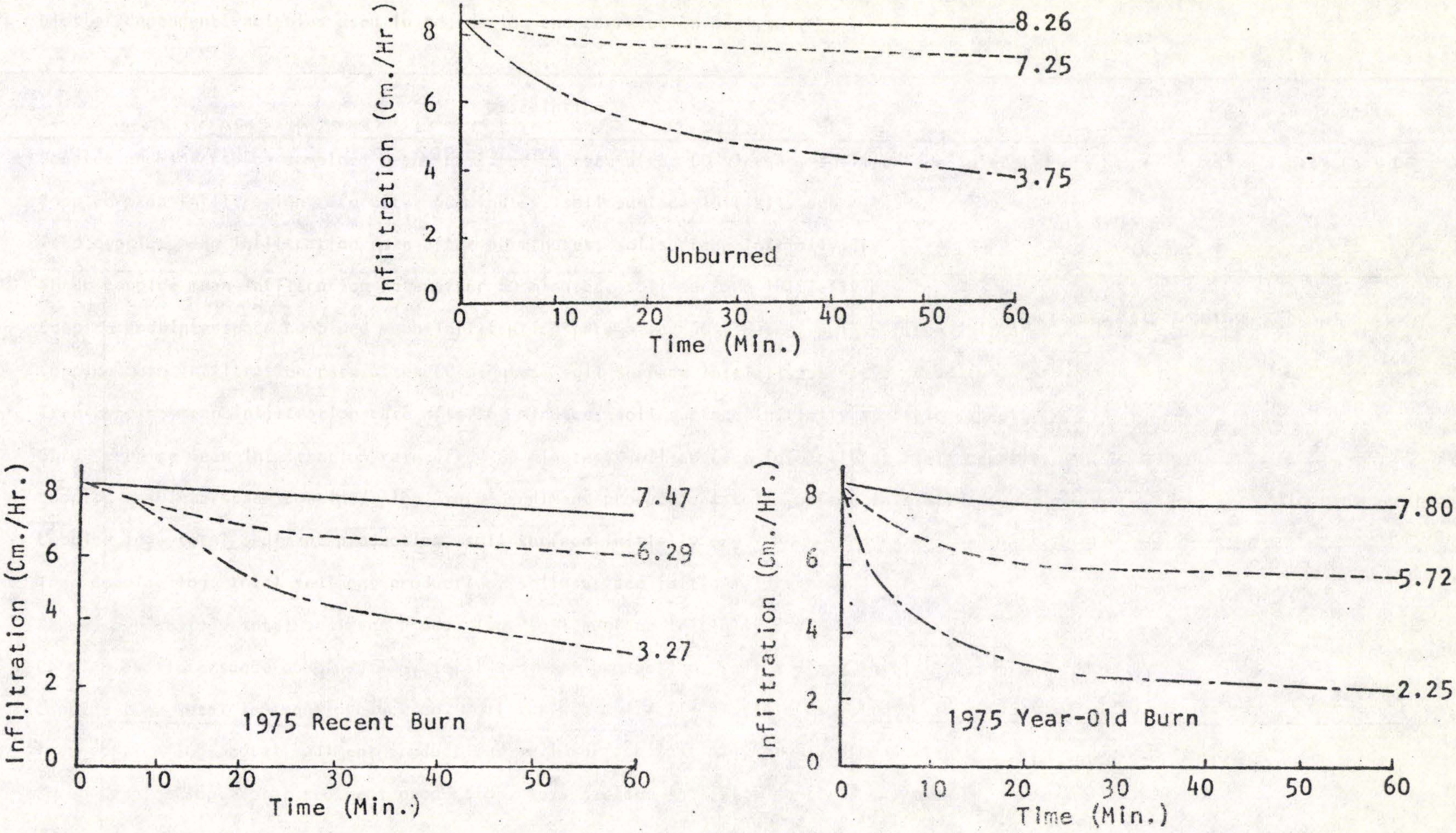

Figure 2. Infiltration curves for unburned and burned treatments, soil initially at field capacity, lower White River, Nevada. Tree coppice =——; shrub coppice =-----; interspace =—·—.

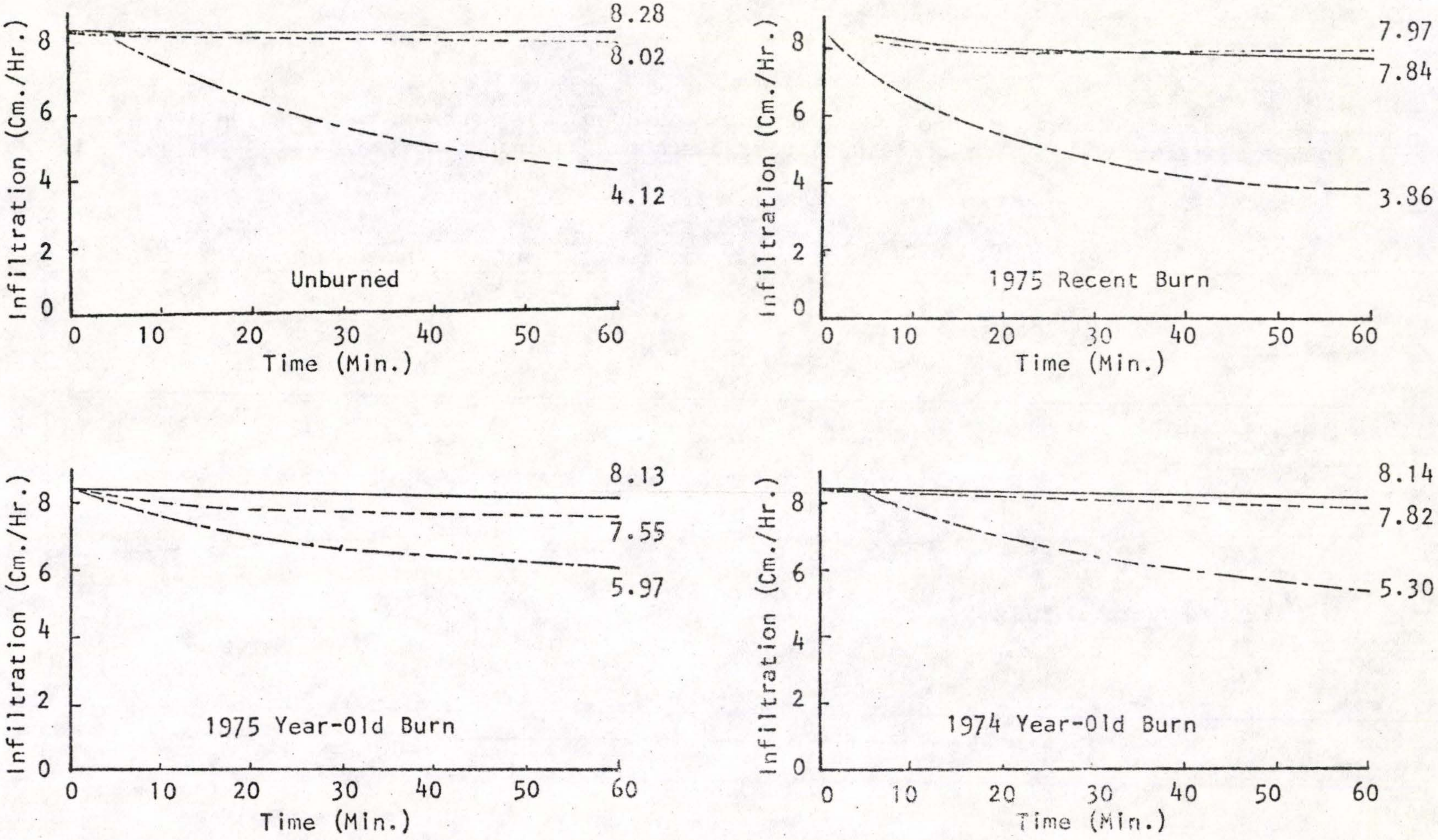

Figure 3. Infiltration curves for unburned and burned treatments, soil initially dry, middle White River, Nevada. Tree coppice =——; shrub coppice =-----; interspace =—·—.

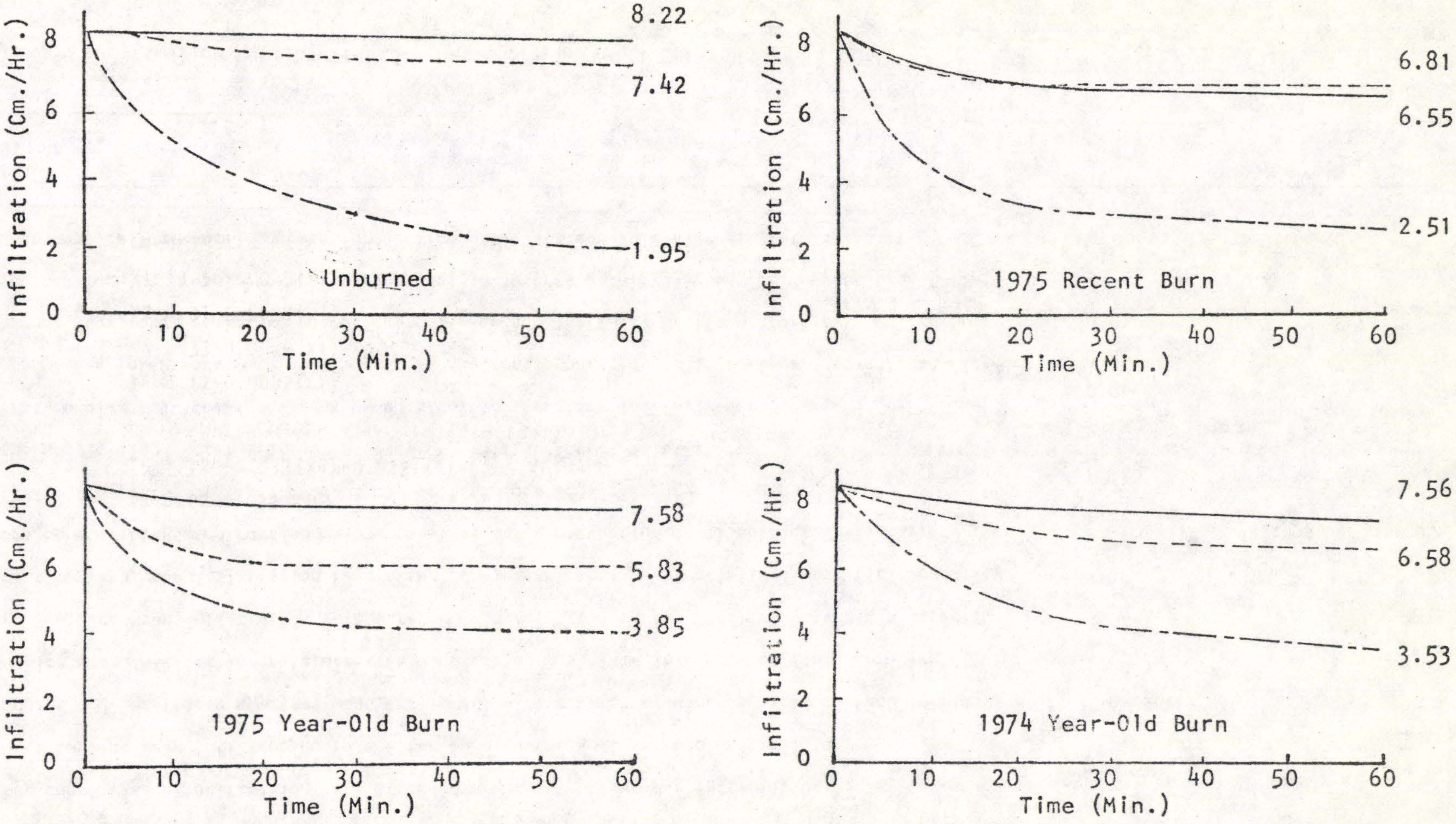

Figure 4. Infiltration curves for unburned and burned treatments, soil initially at field capacity, middle White River, Nevada. Tree coppice = ——; shrub coppice = ------; interspace = —·—.

Appendix I

Table 1. List of dependent variables used in regression and correlation analyses.

Number	Description	Units
Y1	Coppice and interspace combined mean infiltration rate after 60 minutes, soil surface initially dry	Centimeters per hour
Y2	Coppice mean infiltration rate after 60 minutes, soil surface initially dry	" " "
Y3	Tree coppice mean infiltration rate after 60 minutes, soilsurface initially dry	" " "
Y4	Shrub coppice mean infiltration rate after 60 minutes, soil surface initially dry	" " "
Y5	Coppice and interspace combined mean infiltration rate after 60 minutes, soil surface initially at field capacity	" " "
Y6	Coppice mean infiltration rate after 60 minutes, soil surface initially at field capacity	" " "
Y7	Tree coppice mean infiltration rate after 60 minutes, soil surface initially at field capacity	" " "
Y8	Shrub coppice mean infiltration rate after 60 minutes, soil surface initially at field capacity	" " "
Y9	Coppice and interspace combined log. total sediment production, soil surface initially dry	Kilograms per hectare
Y10	Coppice log. total sediment production, soil surface initially dry	" " "
Y11	Tree coppice log. total sediment production, soil surface initially dry	" " "
Y12	Shrub coppice log. total sediment production, soil surface initially dry	" " "
Y13	Coppice and interspace combined log. total sediment production, soil surface initially at field capacity	" " "
Y14	Coppice log. total sediment production, soil surface initially at field capacity	" " "
Y15	Tree coppice log. total sediment production, soil surface initially at field capacity	" " "
Y16	Shrub coppice log. total sediment production, soil surface initially at field capacity	" " "

Appendix J

Table 1 . Independent variables used in infiltration and sediment regression and correlation analyses.

Number	Description	
X1	Bare ground	Percent
X2	Litter cover	"
X3	Litter volume	Cubic decimeters
X4	Vesicular horizon development	Percent
X5	Dry surface soil moisture	Grams per cubic centimeter
X6	Soil bulk density in surface 0-5 cm	" " " "
X7	Soil bulk density in surface 0-10 cm	" " " "
X8	Sand fraction in soil surface horizon	Percent
X9	Organic matter in soil surface horizon	"
X10	Rock (greater than 5 mm)	"
X11	Soil water repellency	"
X12	Silt fraction in the soil surface horizon	"
X13	Clay fraction in the soil surface horizon	"
X14	Vegetation cover	"
X15	Field capacity surface soil moisture	Grams per cubic centimeter

Appendix K

Table 1. Infiltration multiple regression equations for lower and middle White River study sites.

Equation Number	Regression Equations	Coefficient of Determination R^2	Standard Error of Estimate S.E.E.
	Lower White River site, soil initially dry		
1	Y1=13.96-0.025(X4)-0.0067(X1)-3.78(X6)	0.59**	0.91
2	Y2=8.31-0.0098(X1)	0.24**	0.62
3	Y3=8.33-0.0040(X1)-0.0086(X4)	0.31**	0.24
4	Y4=8.12-0.0082(X1)	0.09	0.84
	Lower White River site, soil initially at field capacity		
5	Y5=17.24-0.033(X4)-0.023(X1)-6.05(X6)	0.70**	1.25
6	Y6=8.22-0.027(X1)	0.45**	1.07
7	Y7=8.27-0.023(X1)	0.56**	0.24
8	Y8=7.91-0.024(X1)	0.22**	1.44
	Middle White River site, soil initially dry		
9	Y1=13.56-0.042(X4)-3.65(X7)+0.0065(X2)	0.72**	0.94
10	Y2=8.35-0.0067(X1)-0.022(X4)	0.26**	0.52
11	Y3=8.30+0.0055(X2)-5.78(X5)+0.0055(X3)	0.43**	0.33
12	Y4=8.47-0.030(X4)-0.0074(X1)	0.30**	0.61
	Middle White River site, soil initially at field capacity		
13	Y5=13.36-0.039(X4)+0.017(X2)-4.92(X7)+0.095(X9)+0.019(X3)	0.75**	1.18
14	Y6=8.31-0.025(X1)-0.047(X4)	0.46**	1.03
15	Y7=8.93+0.030(X2)-6.14(X7)+0.095(X8)+0.015(X3)	0.66**	0.76
16	Y8=8.34-0.023(X1)-0.055(X4)	0.43**	1.09

** Significant at the 0.01 level, R^2 values not subscripted are significant at the 0.1 level.

Appendix L.
Table 1. Sediment multiple regression equations for lower and middle White River sites.

Equation Number	Regression Equations	Coefficient of Determination R^2	Standard Error of Estimate S.E.E
	Lower White River site, soil initially dry		
17	$Y9=-0.89+0.0088(X1)+2.01(X6)-0.0066(X3)$	0.49**	0.55
18	$Y10=-2.42-0.012(X2)+3.69(X6)$	0.40**	0.59
19	$Y11=2.54-0.0081(X2)$	0.08	0.73
20	$Y12=-2.28+0.0083(X1)+3.06(X6)$	0.43**	0.29
	Lower White River site, soil initially at field capacity		
21	$Y13=2.43+0.0081(X1)-0.015(X3)$	0.54**	0.50
22	$Y14=-2.26+0.010(X1)-0.0098(X3)+3.07(X6)$	0.54**	0.53
23	$Y15=1.78+0.017(X1)$	0.30**	0.63
24	$Y16=2.56+0.0071(X1)$	0.24**	0.41
	Middle White River site, soil initially dry		
25	$Y9=2.57+0.0047(X1)-0.012(X3)+0.0030(X4)$	0.43**	0.37
26	$Y10=2.49+0.0059(X1)-0.010(X3)+0.0095(X4)$	0.43**	0.39
27	$Y11=2.45-0.0049(X2)-0.012(X3)+4.73(X5)$	0.46**	0.38
28	$Y12=2.52+0.0052(X1)+0.0099(X4)$	0.21**	0.39
	Middle White River site, soil initially at field capacity		
29	$Y13=2.78-0.016(X3)+0.0045(X1)+0.0021(X4)$	0.46**	0.38
30	$Y14=2.70-0.015(X3)+0.0055(X1)+0.0076(X4)$	0.46**	0.41
31	$Y15=2.52+0.011(X1)-0.011(X3)$	0.49**	0.43
32	$Y16=2.74+0.0042(X1)+0.0095(X4)$	0.17*	0.37

** Significant at the 0.01 level. R^2 values not subscripted are significant at the 0.1 level.
* Significant at the 0.05 level.

Appendix M

Table 1. Mean litter cover (%) for coppice dune and dune interspace runoff plots on burned and unburned areas at lower and middle White River, Nevada.

	Mean litter cover (%) for unburned and burned treatments						
	Lower White River site			Middle White River site			
Stratification	Unburned	1975 Recent burn	1975 Year-old burn	Unburned	1975 Recent burn	1975 Year-old burn	1974 Year-old burn
Coppice types and interspace combined	47.9a[1/]	18.1b	21.4b	38.8a	20.9b	10.2c	11.3c
Coppice types combined	78.4a	24.1b	27.2b	84.1a	34.5b	17.6c	17.2c
Tree and shrub coppice separate							
Tree coppice	94.5a	45.8b	80.3a	90.2a	52.7abc	48.0bc	35.3cd
Shrub coppice	63.6ab	12.5c	11.6c	78.4ab	23.0d	6.0e	6.0e
Coppice types and interspace separate							
Pinyon coppice	92.3ab	39.7b	78.4ab	90.2a	44.7abc	69.8ab	44.5abc
Juniper coppice	96.7a	52.7ab	82.2ab	92.3a	60.7ab	32.9bc	46.9abc
Sagebrush coppice	71.4ab	11.9c	11.6cd	76.6a	21.9c	5.5de	5.0de
Bitterbrush coppice	56.5ab	13.1c	12.2cd	80.3a	24.1c	6.6d	7.1cd
Interspace	5.5cd	5.6cd	4.5d	1.0fg	2.2ef	0.4g	1.8fg

1/ Comparisons are made within each study site and within rows for coppice types and interspace combined, and coppice types combined; and within rows and columns for tree and shrub coppice separate, and coppice types and interspace separate. Means followed by the same letter are not significantly different (0.05) as determined by Duncan's multiple range test.

Table 2. Mean bare ground (%) for coppice dune and dune interspace runoff plots on unburned and burned areas at lower and middle White River, Nevada.

	Mean bare ground (%) for unburned and burned treaments						
	Lower White River site			Middle White River site			
		1975	1975		1975	1975	1974
Stratification	Unburned	Recent burn	Year-old burn	Unburned	Recent burn	Year-old burn	Year-old burn
Coppice types and interspace combined	9.2c [1]	51.5a	29.9b	7.1c	32.9b	54.0a	32.1b
Coppice types combined	5.0c	44.7a	22.4b	3.4c	28.5b	49.1a	35.3ab
Tree and shrub coppice separate							
Tree coppice	1.0d	24.7b	6.1c	1.3f	18.5de	26.5cd	20.9d
Shrub coppice	16.8b	80.3a	78.4a	10.2e	44.7bc	90.2a	60.7ab
Coppice types and interspace separate							
Pinyon coppice	1.8ef	35.3ab	10.2cd	0.3h	25.9c-f	19.0e-g	20.9e-g
Juniper coppice	0.4f	17.2bc	3.6de	1.3h	13.1fg	37.0b-e	20.6e-g
Sagebrush coppice	12.8b-d	80.3a	32.2a	12.2fg	52.7a-c	92.3a	71.4ab
Bitterbrush coppice	21.9bc	78.4a	73.1a	8.5g	37.0b-e	88.1ab	50.3a-d
Interspace	88.1a	86.1a	90.2a	92.3a	55.2a-c	74.9ab	21.4d-g

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[1] Comparisons are made within each study site and within rows for coppice types and interspace combined, and coppice types combined; and within rows and columns for tree and shrub coppice separate, and coppice types and interspace separate. Means followed by the same letter are not significantly different (0.05) as determined by Duncan's multiple range test.

Table 3. Mean litter volume (dm^3) for coppice dune and dune interspace runoff plots on unburned and burned areas at lower and middle White River, Nevada.

	Mean litter volume (dm^3) for unburned and burned treatments						
	Lower White River site			Middle White River site			
Stratification	Unburned	1975 Recent burn	1975 Year-old burn	Unburned	1975 Recent burn	1975 Year-old burn	1974 Year-old burn
Coppice types and interspace combined	13.0a[1]	1.8c	4.4b	9.6a	3.0b	1.5bc	1.0c
Coppice types combined	32.0a	2.7b	6.7b	15.0a	4.6b	2.4bc	1.5c
Tree and shrub coppice separate							
Tree coppice	43.0a	8.3c	21.0b	32.0a	12.0b	8.6bc	5.2c
Shrub coppice	5.5c	0.2d	0.4d	4.5c	0.6d	0.03d	0.04d

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[1] Comparisons are made within each study site and within rows for coppice types and interspace combined; and within rows and columns for tree and shrub coppice separate. Means followed by the same letter are not significantly different (0.05) as determined by Duncan's multiple range test.

Table 4. Mean vesicular horizon development (%) for coppice dune and dune interspace runoff plots on unburned and burned areas at lower and middle White River, Nevada.

	Mean vesicular horizon development (%) for unburned and burned treatments						
	Lower White River site			Middle White River site			
Stratification	Unburned	1975 Recent burn	1975 Year-old burn	Unburned	1975 Recent burn	1975 Year-old burn	1974 Year-old burn
Coppice types and interspace combined	5.9ab[1]	9.5a	3.3b	7.9a	5.8ab	3.7b	4.5ab
Coppice types combined	3.0ab	5.8a	1.3b	4.1a	3.1ab	1.4b	2.9ab
Tree and shrub coppice separate							
Tree coppice	0.8b	1.8b	0.7b	2.9ab	2.1ab	0.5b	1.6ab
Shrub coppice	7.9a	15.6a	1.7b	5.6a	4.4a	2.7ab	4.9a
Coppice types and interspace separate							
Pinyon coppice	1.3d-f	2.9c-e	0.0f	2.4d-g	3.4d-g	0.2g	1.2fg
Juniper coppice	0.3ef	1.0ef	2.1c-f	3.6d-g	1.2fg	1.0g	2.0d-g
Sagebrush coppice	6.8b-d	14.8b	4.0b-e	3.8d-f	3.5d-g	3.7d-g	2.1d-g
Bitterbrush coppice	9.5bc	16.4b	0.4ef	8.1c-e	5.3c-f	1.9e-g	10.5cd
Interspace	60.7a	59.3a	82.2a	84.1a	51.5ab	60.0a	19.4bc

1/ Comparisons are made within each study site and within rows for coppice types and interspace combined, and coppice types combined; and within rows and columns for tree and shrub coppice separate, and coppice types and interspace separate. Means followed by the same letter are not significantly different (0.05) as determined by Duncan's multiple range test.

Table 5. Mean (0-5 cm) surface-soil organic matter (%) for coppice dune and dune interspace areas on unburned and burned treatments at lower and middle White River, Nevada.

	Mean organic matter (%) for unburned and burned treatments				
	Lower White River site		Middle White River site		
Stratification	Unburned	1975 Year-old burn	Unburned	1975 Year-old burn	1974 Year-old burn
Coppice types and interspace combined	5.40a [1]	5.33a	6.27a	6.00a	6.60a
Coppice types combined	6.19a	5.87a	7.69a	6.61a	7.26a
Tree and shrub coppice separate					
Tree coppice	7.33a	7.01a	9.34a	5.96b	7.43ab
Shrub coppice	5.37a	4.42a	6.04b	7.25ab	7.09ab
Coppice types and interspace separate					
Pinyon coppice	6.99ab	8.12a	6.87bc	6.14b-d	7.67b
Juniper coppice	7.02ab	6.53a-c	11.81a	5.78b-d	7.18bc
Sagebrush coppice	6.02a-c	4.81a-c	7.21bc	6.43b-d	6.44b-d
Bitterbrush coppice	4.73a-c	4.04a-c	4.87b-d	8.07b	7.74b
Interspace	2.26c	3.14bc	0.60e	3.56de	3.95cd

[1] Comparison are made within each study site and within rows for coppice types and interspace combined, and coppice types combined; and within rows and columns for tree and shrub coppice separate, and coppice types and interspace separate. Means followed by the same letter are not significantly different (0.05) as determined by Duncan's multiple range test.

Table 6. Soil bulk density (g/cm^3) for coppice dune and dune interspace areas for unburned and burned treatments at lower White River, Nevada.

	Bulk density (g/cm^3) for unburned and burned treatments					
	0-5 centimeters			0-10 centimeters		
Stratification	Unburned	1975 Recent burn	1975 Year-old burn	Unburned	1975 Recent burn	1975 Year-old burn
Coppice types and interspace combined	1.50	1.48	1.52	1.55	1.56	1.61
Coppice types combined	1.48	1.46	1.50	1.54	1.54	1.61
Tree and shrub coppice separate						
Tree coppice	1.43	1.46	1.50	1.52	1.53	1.63
Shrub coppice	1.53	1.46	1.51	1.55	1.56	1.59
Coppice types and interspace separate						
Pinyon coppice	1.46	1.48	1.47	1.54	1.51	1.60
Juniper coppice	1.40	1.44	1.52	1.50	1.55	1.66
Sagebrush coppice	1.56	1.49	1.47	1.59	1.59	1.55
Bitterbrush coppice	1.49	1.43	1.55	1.51	1.52	1.62
Interspace	1.58	1.58	1.57	1.59	1.64	1.64

Table 7. Soil bulk density (g/cm^3) for coppice dune and dune interspace areas on unburned and burned treatments at middle White River, Nevada.

Stratification	Unburned	1975 Recent burn	1975 Year-old burn	1974 Year-old burn	Unburned	1975 Recent burn	1975 Year-old burn	1974 Year-old burn
	Bulk density (g/cm^3) for unburned and burned treatments							
	0-5 centimeters				0-10 centimeters			
Coppice types and interspace combined	1.54	1.56	1.47	1.55	1.59	1.58	1.59	1.58
Coppice types combined	1.54	1.53	1.45	1.51	1.60	1.61	1.57	1.54
Tree and shrub coppice separate								
Tree coppice	1.54	1.53	1.41	1.49	1.63	1.60	1.54	1.50
Shrub coppice	1.55	1.54	1.50	1.53	1.57	1.56	1.64	1.59
Coppice types and interspace separate								
Pinyon coppice	1.51	1.53	1.29	1.51	1.64	1.59	1.47	1.52
Juniper coppice	1.56	1.53	1.52	1.47	1.62	1.60	1.60	1.47
Sagebrush coppice	1.50	1.56	1.56	1.47	1.51	1.58	1.59	1.54
Bitterbrush coppice	1.59	1.51	1.43	1.58	1.62	1.54	1.60	1.63
Interspace	1.56	1.66	1.57	1.72	1.57	1.76	1.67	1.76

Appendix N
Table 1. Post-burn cover for shrubs, forbs, and grasses for Burn #1 (24 April '75) in the fall and spring of 1975 and 1976.

	Percent Cover			
Species	Sp. 1975	F. 1975	Sp. 1976	F. 1976
SHRUBS				
Chrysothamnus viscidiflorus	.1	.3	.6	.7
Total Shrub	0	.3	.6	.7
FORBS				
Amsinckia sp.	0	.1	.2	1.2
Astragalas sp.	0	.1	.3	.3
Chenopodium album	0	T	1.2	2.0
Descurania sophia	0	0	.5	.2
Eriastrum sparsiflorum	T	T	T	.2
Gayophytum remossisimum	0	0	.1	.1
Gilia sp.	0	.4	1.0	0
Lupinus sp.	.1	.2	1.6	4.2
Mentzelia albicaulis	0	0	T	.1
Nicotiana attenuata	T	.8	2.7	6.5
Total Forb	.2	1.6	7.6	14.8
TOTAL VEGETATION COVER	.3	1.9	8.2	15.5
GROUND COVER				
Litter	11.1	9.4	28.3	21.1
Bareground	86.7	86.1	60.6	67.2
Rock	1.7	0	.6	.6
Pavement	0	1.1	1.1	0
Live vegetation	.5	3.3	9.4	11.1

Table 2. Post-burn for shrubs, forbs, and grasses for Burn #2 (3 May '75) in the fall and spring of 1975 and 1976.

Species	Percent Cover Sp. 1975	F. 1975	Sp. 1976	F. 1976
SHRUBS				
Chrysothamnus viscidiflorus	.5	4.0	4.0	4.0
Total Shrub	.5	4.0	4.0	4.0
FORBS				
Argemone platyceras	0	.1	.7	2.4
Eriastrum sparsiflorum	0	T	T	.9
Gayophytum remossisimum	0	0	.6	2.3
Gilia sp.	0	0	T	.1
Lupinus sp.	0	0	.9	2.7
Lygodesmia spinosa	0	0	.1	.3
Nicotiana attenuata	0	0	2.9	4.2
Sphaeralcea coccinea	0	.7	.5	.6
Total Forb	0	.8	5.7	13.5
GRASSES				
Elymus	0	0	.4	.8
Total Grass	0	0	.4	.8
GROUND COVER				
Litter	14.2	13.3	11.7	15.0
Bareground	75.8	73.3	70.0	71.7
Rock	.8	0	1.7	0
Pavement	8.3	11.7	6.7	0
Live vegetation	.8	1.7	10	13.3

Table 3. Post-burn cover for shrubs, forbs, and grasses for Burn #3 (9 May '75) in the fall and spring of 1975 and 1976.

Species	Percent Cover			
	Sp. 1975	F. 1975	Sp. 1976	F. 1976
SHRUBS				
Chrysothamnus viscidiflorus	0	0	T	.1
Total Shrub	0	0	T	.1
FORBS				
Amsinckia sp.	0	0	.1	.2
Argemone platyceras	T	.4	.8	2.7
Astragalas sp.	0	0	T	.1
Chenopodium album	T	.2	.6	1.4
Eriastrum sparsiflorum	0	T	0	0
Gayophytum remossisimum	T	0	.4	3.6
Gilia sp.	0	0	.1	T
Lupinus sp.	0	0	T.	0
Mentzelia albicaulis	0	0	0	1.0
Nicotiana attenuata	T	0	.3	1.7
Sphaeralcea coccinea	0	.4	.5	.7
Total Forb	.2	1.0	2.9	11.4
GRASSES				
Elymus cinereus	0	.1	.6	.5
Total Grass	0	.1	.6	.5
TOTAL VEGETATION COVER	.2	1.1	3.5	12.0
GROUND COVER				
Litter	30.8	28.7	32.1	31.7
Bareground	56.7	59.6	59.2	57.5
Rock	2.1	2.1	2.1	1.2
Pavement	10.0	2.9	4.6	0
Live vegetation	.4	1.7	2.1	9.6

Table 4. Post-burn cover for shrubs, forbs, and grasses for Burn #4 (16 May '75) in the fall and spring of 1975 and 1976.

	Percent Cover			
Species	Sp. 1975	F. 1975	Sp. 1976	F. 1976
SHRUBS				
Amelanchier alnifolia	.1	.1	.1	0
Chrysothamnus viscidiflorus	0	0	.7	2.2
Total Shrub	.1	.1	.8	2.2
FORBS				
Amsinckia sp.	0	0	0	T
Carex sp.	.1	.5	.9	1.0
Eriastrum sparsiflorum	0	.2	0	0
Gayophytum remossisimum	0	0	.2	1.4
Gilia sp.	0	0	.1	.2
Lygodesmia spinosa	.2	1.1	1.5	4.7
Sphaeralcea coccinea	0	0	0	.5
Total Forb	.3	1.8	2.7	7.8
GRASSES				
Elymus cinereus	0	0	0	.1
Total Grass	0	0	0	.1
TOTAL VEGETATION COVER	.4	1.9	3.5	10.1
GROUND COVER				
Litter	17.5	13.3	22.5	20.0
Bareground	61.7	70.8	67.5	73.3
Rock	0	0	0	0
Pavement	20.8	12.5	10.0	0
Live vegetation	0	3.3	0	6.7

Table 5. Post-burn cover for shrubs, forbs, and grasses for Burn #5 (12 June '75) in the fall and spring of 1975 and 1976.

	Percent Cover			
Species	Sp. 1975	F. 1975	Sp. 1976	F. 1976
FORBS				
Argemone platyceras	0	0	0	.1
Descurania sophia	0	0	0	.2
Gayophytum remossisimum	0	0	.2	1.2
Gilia sp.	0	0	.3	.8
Lupinus sp.	0	T	0	0
Sphaeralcea coccinea	0	.8	2.3	1.0
Unknown	0	0	.4	.3
Total Forb	0	.8	3.2	3.6
GRASSES				
Elymus cinereus	.1	0	T	0
Oryzopsis hymenoides	.2	.2	.7	.9
Total Grass	.3	.2	.7	.9
TOTAL VEGETATION COVER	.3	1.0	3.9	4.5
GROUND COVER				
Litter	15.0	15.0	13.3	20.0
Bareground	61.7	70.8	67.5	70.0
Rock	5.0	5.0	5.0	3.3
Pavement	11.7	5.0	0	5.0
Live vegetation	0	0	5.0	1.7

APPENDIX O

TABLE 1. Shrub density by maturity class and species on burned and unburned areas of eleven burn sites in Nevada and California.

		2 Year Old Burns				3 Year Old Burn		4 Year Old Burn		16 Year Old Burn		17 Year Old Burn	
		Mt. Wilson		China Garden[1/]		Rock Creek[1/]		Davis Creek[2/]		Cottonwood Creek[2/]		North Fork Cottonwood Creek[2/]	
Species Density (1,000's Per Hectare)	Class**	B[4/]	U[5/]	B	U	B	U	B	U	B	U	B	U
Artemisia tridentata	1											1.2	
	2	2.2								.1		11.9	3.7
	3	2.9	7.3		.5		.5			15.4	3.0	9.9	2.5
	4		1.5									.3	.8
TOTAL		5.1	8.8		.5		.5			15.5*	3.0	23.3*	7.0
Artemisia nova	1												
	2											.4	1.5
	3											1.7	5.4
	4												1.1
TOTAL												2.1	8.0
Purshia Glandulosa	1												
	2												
	3												
	4												
TOTAL													
Purshia Tridentata	1												
	2			.1									.3
	3		4.3		1.4		1.4					1.3	1.4
	4												
TOTAL			4.3	.1	1.4		1.4					1.3	1.7
Chrysothamnus Viscidiflorus	1												
	2											2.3	.5
	3		4.8									5.7	1.1
	4												
TOTAL			4.8									8.0	1.6
Symphoricarpus Alba	1												
	2												
	3												
	4												
TOTAL										.1	1.9		
Ephedra Viridis	1												
	2												
	3												
	4												
TOTAL													
Ribes Inerme	1												
	2												
	3					.4		.3	.1				
	4												
TOTAL						.4		.3	.1				
Cercocarpus Ledifolus	1												
	2												
	3								.2				
	4												
TOTAL									.2				
Other	1												
	2			2.2								.1	
	3								.5	1.2		.3	1.3
	4												
TOTAL				2.2					.5	1.2		.4	1.3
Total	1											1.2	
	2	2.2		2.3						.2		14.7	6.0
	3	2.9	16.4		1.9	.4	1.9	.3	.8	16.6	4.9	18.9	11.7
	4		1.5									.3	1.9
GRAND TOTAL		5.1	17.9	2.3	1.9	.4	1.9	.3	.8	16.8	4.9	35.1	19.6

[1/] California Sites
[2/] Quinn Canyon Sites
[3/] Ward Mountain Sites
[4/] Burned
[5/] Unburned
[6/] Elevation in meters

* Part of 115 year old burn

** 1 - Seedling
2 - Young
3 - Mature
4 - Decadent

APPENDIX P

Table 1. Pinyon, juniper and total tree densities by maturity classes on burned and unburned areas of eleven study sites in Nevada and California.

Species Density (Per Hectare)	Class**	2 Year Old Burns				3 Yr. Old Burn		4 Yr. Old Burn		16 Yr. Old Burn		17 Yr. Old Burn	
		Mt. Wilson		China Garden1/		Rock Creek1/		Davis Creek2/		Cottonwood Ck.2/		North Fork Cottonwood2/	
		B3/	U4/	B	U	B	U	B	U	B	U	B	U
Pinus monophylla	1	0	26	0	96	0	96	0	160	0	25	2	11
	2	0	52	0	189	0	189	0	251	0	55	0	33
	3	0	73	0	174	0	174	0	356	0	125	0	24
	4	0	152	0	301	0	301	0	1005	0	315	0	13
	5	0	16	0	40	0	40	0	52	0	85	0	1
	6	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	319	0	800	0	800	0	1824	0	605	2	82
Juniperus osteosperma	1	0	4	0	0	0	0	0	0	0	0	0	11
	2	0	0	0	0	0	0	0	0	0	0	0	24
	3	0	9	0	0	0	0	0	0	0	0	0	29
	4	0	8	0	0	0	0	0	0	0	0	0	42
	5	0	3	0	0	0	0	0	0	0	0	0	11
	6	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	24	0	0	0	0	0	0	0	0	0	117
Total Tree Density		0	343	0	800	0	800	0	1824	0	605	2	199

		24 Yr. Old Burns				45 Yr. Old Burn		115 Yr. Old Burns			
		2085 m5/		2180 m.		2110 m.		1985 m.		2170 m.	
		B3/	U4/	B	U	B	U*	B	U	B	U
Pinus monophylla	1	1	0	1	48	0	8	15	30	7	48
	2	0	5	0	92	3	19	16	14	48	92
	3	0	3	0	133	9	15	53	42	70	133
	4	0	5	0	249	1	9	50	105	64	249
	5	0	0	0	83	0	0	3	97	0	83
	6	0	0	0	4	0	0	0	3	0	4
	Total	1	13	1	609	13	51	137	291	189	609
Juniperus osteosperma	1	2	150	1	51	9	11	16	3	17	51
	2	3	215	6	127	32	114	79	32	96	127
	3	2	160	3	183	24	137	90	108	128	183
	4	1	73	0	207	0	149	84	157	137	207
	5	0	60	0	124	0	46	60	212	1	124
	6	0	21	0	13	0	2	4	40	0	13
	Total	8	679	10	705	65	459	333	552	379	705
Total Tree Density		9	692	11	1314	78	510	470	843	568	1314

1/ California Sites
2/ Quinn Canyon Sites
3/ Burned
4/ Unburned
5/ Elevation in Meters

* Part of 115 Year Old Burn
**

1 Seedling
2 Young Sapling
3 Sapling
4 Mature vigorous
5 Mature Old
6 Decadent

TABLE 1. (Cont'd)

		24 Year Old Burn				45 Year Old Burn		115 Year Old Burn			
		2085 m[6]		2180 m		2110 m		1985 m		2170 m	
Species Density (1,000's per Hectare)	Class	B	U	B	U	B	U*	B	U	B	U
Artemisia tridentata	1			.1							
	2			1.4	.2			.3		.3	.2
	3			8.1	.9			3.8	.2	1.4	.9
	4			.3				.5		.2	
	TOTAL			9.9	1.1			4.6	.2	1.9	1.1
Artemisia nova	1	.2	.4	.1							
	2	4.0	1.1	.7		.6	.8	1.4		.7	
	3	11.1	4.7	2.4		17.6	13.9	6.3	.8	8.8	
	4	4.4	7.9			9.2	5.8	2.0	.1	2.7	
	TOTAL	19.7	14.1	3.2		27.4	20.3	9.7	.9	12.2	
Purshia glandulosa	1		.1	.4	.4			.1			.4
	2	.1	.2	.3	.2	.2	.3			.2	.2
	3	1.9	.1	2.5	.4	.6	.9	1.0	.1	2.1	.4
	4				.1					.6	.1
	TOTAL	2.0	.4	3.2	1.1	.8	1.2	1.1	.1	2.9	1.1
Purshia tridentata	1										
	2										
	3										
	4										
	TOTAL										
Chrysothamnus viscidiflorus	1	3.0	.2								
	2	9.2	2.1	5.3		4.6	1.5	.8		.3	
	3	5.7	1.7	6.2		6.8	1.5	4.3		4.5	
	4	2.8	.2	.6						.3	
	TOTAL	20.7	4.2	12.1		11.4	3.0	5.1		5.1	
Symphoricarpus alba	1										
	2										
	3										
	4										
	TOTAL									.5	
Ephedra viridis	1										
	2										
	3				.1				.1		.1
	4										
	TOTAL				.1				.1		.1
Ribes inerme	1										
	2										
	3			.1					.3	.3	
	4										
	TOTAL			.1					.3	.3	
Cercocarpus ledifolus	1										
	2				.1						.1
	3				.1						.1
	4										
	TOTAL				.2						.2
Other	1										
	2									.1	
	3					.2	.2			.2	
	4										
	TOTAL					.2	.2			.3	
Total	1	3.2	.7	.7	.4			.1			.4
	2	13.3	3.4	7.8	.5	5.4	2.6	2.5		1.6	.5
	3	18.7	6.5	19.6	1.5	25.2	16.3	15.4	1.5	17.8	1.5
	4	7.2	8.1	.9	.1	9.2	5.8	2.5	.1	3.8	.1
	GRAND TOTAL	42.4	18.7	29.0	2.5	39.8	24.7	20.5	1.6	23.2	2.5

Appendix Q. Table 1. List of mammal species, by order and family, which were encountered on study sites in the White River area, EasternNevada.

Order	Family	Scientific Name	Common Name
Lagamorpha	Leporidae	*Sylvilagus audubonі*	Desert cottontail*
		Lepus californicus	Black-tailed jackrabbit*
	Sciuridae	*Eutamias minimus*	Least chipmunk
		Spermophilus variegatus	Rock squirrel
	Heteromyidae	*Dipodomys ordii*	Ord's kangaroo rat
		Peragnathus formosus	Longtailed pocket mouse
		Peragnathus longimembris	Little pocket mouse
	Cricitidae	*Reithrodontomys megalotis*	Western harvest mouse
		Peromyscus maniculatus	Deer mouse
		Peromyscus trueii	Pinyon mouse
		Onychomys leucogaster	Northern grasshopper mouse
		Lagurus curtatus	Sagebrush vole
		Microtus longicaudas	Longtail vole
Carnivora	Canidae	*Canis latrans*	Coyote*
	Mustelidae	*Mustela frenata*	Long-tailed weasel
Artiodactyla	Cervidae	*Odocoileus heminous*	Mule deer*

* These species were sighted on burned areas but were not captured during the study.

Table 2. List of bird species, by order and family, which were encountered on study sites in the White River area of Eastern Nevada.

Order	Family	Scientific Name	Common Name
Falconiformes	Accipitridae	*Buteo jamaicensis*	Red-tailed hawk
	Accipitridae	*Accipter cooperii*	Cooper's hawk
	Falconidae	*Falco sparverins*	American kestrel
Columbifores	Columbidae	*Zenaidura macrouna*	Mourning dove
Caprimulgiformes	Caprimulgidae	*Chordeiles minor*	Common nighthawk
Apodiformes	Trachilidae	*Stellula calliope*	Calliope hummingbird
Piciformes	Picidae	*Dendiocapas villosus*	Hairy woodpecker
Passeriformes	Tyrannidae	*Tryannus verticalus*	Western kingbird
	Tryannidae	*Epidomax wrightii*	Gray flycatcher
	Hirundinidae	*Steligidopteryx ruficallis*	Rough-winged swallow
	Cervidae	*Aphelocoma caerulescens*	Scrub jay
	Cervidae	*Corvus corax*	Common raven
	Cervidae	*Gymnorhinus cyancephola*	Pinyon jay
	Paridae	*Parus gambeli*	Mountain chickadee
	Paridae	*Parus inornatus*	Plain titmouse
	Paridae	*Psaltriparus minimus*	Common bushtit
	Turdidae	*Turdus migratorius*	Robin
	Turdidae	*Siala currcoides*	Mountain bluebird
	Sylviidae	*Polioptila caerulea*	Blue-gray gnatcatcher
	Vieronidae	*Vireo vicinio*	Gray vireo
	Parulidae	*Dendroica nigrescens*	Black-ghroated gray warbler
	Parulidae	*Dendroica audubonii*	Audubon's warberl
	Icteridae	*Euphalagus lyanocephalus*	Brewer's blackbird
	Thyranupidae	*Piranga ludoviciana*	Western tanager
	Fringillidae	*Passerina amoena*	Lazuli bunting
	Fringillidae	*Carpodacus purpureus*	Purple finch
	Fringillidae	*Spinus pinus*	Pine siskin
	Fringillidae	*Chlorura chlorura*	Green-tailed towhee
	Fringillidae	*Pipillo erythrophthalmus*	Rufous-sided towhee
	Fringillidae	*Passerculus sandwhichensis*	Savannah sparrow
	Fringillidae	*Chordestes gramecus*	Lark sparrow
	Fringillidae	*Amphispize bilineata*	Black throated sparrow
	Fringillidae	*Spizella passerina*	Chipping sparrow
	Fringillidae	*Spizella breweri*	Brewer's sparrow
	Fringillidae	*Spizella atrogularis*	Blackchinned sparrow